An Assessment of Maritime Forest Resources on the North Carolina Coast

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Executive Summary

Maritime forests can be defined as the woody plant communities that develop as an end result of primary succession on coastal barrier islands. Maritime forests generally develop on stabilized dune systems located on the sound-side of islands whose width, topography and orientation provide sufficient protection from storm exposure. Maritime forests are composed of a unique assemblage of species adapted to survive and reproduce under the harsh conditions associated with a coastal barrier system such as: salt spray, wind shear, nutrient poor soils and low water availability.

From early native American settlements to current condominium construction, maritime forests along the North Carolina coast have experienced centuries of use and abuse by man. Today, these unique forests are virtually gone and what remain are a series of isolated tracts, encroached upon yearly by an ever increasing tide of coastal development. As presented in this report, there are less than 25 large maritime forest sites (i.e., greater than 20 acres) remaining on the barrier islands (see Fig. 1). If we exclude northern Currituck Banks (5,000 acres of indiscrete sound side forest fringe) these sites total less than 7000 acres. Of these sites, 18 are partially or entirely in private ownership (see Appendix B). Given the current rate of barrier island development, most of this privately owned forest will be destroyed or significantly altered within the next decade. The goal of this report is to provide the information necessary to allow future management decisions to be made on a scientifically sound and comprehensive basis so that maritime forests can be conserved as part of our coastal heritage.

This report represents the first assessment of what remains of the maritime forest ecosystem in North Carolina. A total of 24 forest areas were surveyed on 16 barrier islands in North Carolina (see Fig. 1). Potentially forested areas were first identified from large-scale aerial photos. Field trips were then made to each of these areas to verify the existence of intact forests. Each site was described from an ecological standpoint, surrounding land uses were recorded and boundaries of the intact forest areas were delineated. Tax records were then used to compile a list of landowner names and addresses, as well as acreages for each surveyed parcel.

General information concerning the history of forest use on different islands was obtained from the literature, town halls, and personal communications, and is described in the forest site summaries. In addition to an inventory of specific forest tracts, this report also contains a general review of the ecology, conservation biology, and current management of maritime forests in this state.

One of the important facts we are only now beginning to realize about maritime forests is that they are particularly susceptible to the deteriorating effects of fragmentation. This is largely due to the severe environmental conditions under which they exist. Patches of maritime forests that are left in areas that have been partially cleared for development, rapidly deteriorate due to the sudden exposure to salt spray, wind shear, altered drainage, the invasion of weedy species and other factors. This deterioration starts at the forest edges and works inward. Substantially larger areas than one would normally leave inland, must be left intact during development if the ecological integrity of a maritime forest stand is to be maintained.

One result of fragmentation is the loss of continuity with other forest areas and with other habitat types. This is a critical loss to animal species that depend on the maintenance of forest transition areas for their survival. Fragmentation isolates forest populations by resticting dispersal and preventing gene flow. This can ultimately lead to increased homozygosity and a build-up of lethal recessive genes within a population.

By being located on islands, maritime forests are already isolated to a certain degree. Fragmentation dramatically compounds the ecological effect of this isolation by essentially creating islands of forest within islands. The greater the density of development allowed, the more the forest will become fragmented. There is a minimal area at which a forest fragment is still capable of maintaining itself in terms of seedling recruitment into the canopy population. There is also a minimum area which will support the same number of plant and animal species as would a comparable area of undisturbed forest. Below this minimum size, species will be lost, and those still present may no longer be capable of replacing themselves. The loss of species and individuals will continue until the forest fragment no longer retains any of its original character.

Unfortunately this theoretical "minimum area" is site specific and depends upon a variety of environmental conditions. Since in practical terms it is often necessary to specify an ecologically sound minimum area, it is best to err on the safe side and allow a very wide margin of buffer between clearings. As a rule, lot sizes of 80,000 sq. ft. should be considered a lower limit in any maritime forest site.

Forest clearing and filling of wetlands can alter the hydrology of a maritime forest and even the hydrology of an entire island. Maritime forests serve to protect and recharge freshwater aquifers that develop within barrier islands. These aquifers are often the sole source of fresh water for the inhabitats of an island and so their protection is vital.

Maritime forests can and should be managed in a manner that avoids or minimizes harmful impacts to the ecosystem. This protection can be acheived through the implementation of one or a combination of the following measures:

1. Preservation through public acquisition (federal, state, or local government) or by conservation organizations.

2. Enforcement of existing federal and state environmental regulations.

3. Resource management through designation as an Area of Environmental Concern (AEC) by the N.C. Coastal Resources Commission.

4. Resource management through local government zoning.

5. Conservation through development policies and land classifications prescribed in the local land use plan.

6. Conservation through landowner's voluntary protection. (Possible registration with the NC Natural Heritage Program as a protected natural area.)

This report reviews the current and potential effectiveness of these measures. It was generally found that federal and local measures are inadequate and that the greatest level of future protection for maritime forests lies at the state level.

There is a clear mandate implicit in the North Carolina Coastal Area Management Act (CAMA) of 1974 (N.C.G.S. 113A-100 et seq.) for the protection of maritime forest resources. State protection for maritime forests would be available if the N.C. Coastal Resources Commision (CRC) were to designate maritime forests as "areas of environmental concern" (AECs). CAMA authorizes the CRC to manage development in AECs by requiring that development within these areas be consistent with standards designed to protect critical coastal resources. While we have general AEC categories covering the estuarine system, public trust waters and beaches, there is currently no uniform category regulating development in the maritime forest ecosystem, even though it is a important component of the barrier dune system as specifically covered under CAMA.

The CRC could decide to create a new maritime forest AEC category and establish management objectives and general use standards for new development proposed within the AEC. This would be a preferred option over the designation of specific areas on an independent basis, since a set of uniform state standards would provide the most comprehensive regulation and would the most fair since since no one forest area would be treated differently from another.

We are at a critical juncture in the fate of maritime forests in North Carolina. Major changes in policy need to be made soon to prevent the loss of this unique ecosystem. It is highly recommended that the following actions be taken towards maritime forest protection and preservation in this state:

1. Development of maritime forests should be slowed down; uniform standards should be imposed on a state-wide basis to insure adequate protection. Area of Environmental Concern status, such as has been given to salt marshes and other important natural systems, should also be applied to the maritime forest ecosystem as a whole (as delineated in this report).

2. Current and future regulations need to be more rigorous with regard to the conservation of maritime forests. Regulations, whether they be local development standards, AEC use standards or Corps 404 wetland regulations, should be strictly enforced.

3. Attempts should be made at the state and federal level to purchase priority forest areas (See Appendix B). Those sites with the highest habitat diversity and largest size should be the initial focus of this drive.

4. Future research in maritime forests needs to be encouraged; public awareness and education programs are needed to convey the importance of maritime forests as an essential part of the barrier island environment and as a unique component of our coastal heritage.

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PREFACE

In the 16th century when European explorers first set foot on what is now the North Carolina coast, the forests they initially encountered were the magnificent maritime forests of the coastal barrier islands. These original forests, composed of enormous spreading live oaks and red cedars, had served as traditional Native American hunting grounds for thousands of years prior to the advent of Europeans. It was within the protective cover of the maritime forests that the historic towns of Buxton, Ocracoke, Portsmouth and Diamond City developed and flourished during the 18th and 19th centuries. In the second half of the 20th century, it was the stable maritime forest areas that provided the alternative sites for vacation homes, condominiums, and shopping malls when the prime beach-front real estate had been developed or had eroded away. Today, after centuries of use and abuse by man, the maritime forests are virtually gone. What remain are a series of isolated tracts that are being encroached upon yearly by an ever increasing tide of coastal development. The continued existence of the maritime forest ecosystem in North Carolina (and along the rest of the U.S. Atlantic Coast) is in question and management decisions made over the next several years will be critical in the determination of its fate.

It is the intent of this report to provide the information necessary to allow these management decisions to be made on a scientifically sound and comprehensive basis. This report represents the first assessment of what remains of the maritime forest ecosystem in North Carolina. In addition to an inventory of specific forest tracts, this report contains a general review of the ecology and current management of maritime forests in this state. It is our hope that this report will serve not only as a catalyst for additional studies of maritime forests; but that it will provide the foundation for a new set of uniform policies and protective measures designed to insure the preservation of this unique part of our coastal heritage.

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I. The Ecology of North Carolina Maritime Forests

Introduction

Maritime forests are the woody plant communities that develop as an end result of primary succession on coastal dune systems. Maritime forests, unlike inland forests, develop adjacent to and under the influence of an oceanic exposure. In North Carolina, maritime forests are generally restricted to the coastal barrier islands. However, not all barrier islands have maritime forests. Maritime forests generally develop on stabilized dune systems located on the sound-side of islands whose width, topography and orientation provide sufficient protection from storm exposure (Bourdeau and Oosting 1959). Maritime forests are composed of a unique assemblage of species adapted to survive and reproduce under the harsh conditions associated with a coastal barrier system. These conditions include salt spray, wind shear, nutrient poor soils and low water availability (Barbour et al. 1985).

There is considerable variation in species composition and abundance within a given forest area on an island and among forests of different islands. In general, maritime forests in North Carolina represent a floristic transition between the subtropical, broad-leaf evergreen species of the southern coastal forests and the temperate deciduous elements of the northern-forests. Bald Head Island, for example, represents the northern most range for the palmetto palm (Sabal palmetto) while American beech (Fagus grandiflora) is only found in the maritime forests north of Nags Head. In North Carolina, maritime forests are most typically associated with two important tree species: live oak (Quercus virginiana) and red cedar (Juniperus virginiana). A third species, loblolly pine (Pinus taeda), is a common early successional species that becomes established following disturbance events. All three of these species are found throughout the range of maritime forests in this state.

While general climatic conditions affect maritime forest species composition along a latitudinal gradient, other factors such as an island's age, geomorphology, distance from mainland and history of disturbance also contribute greatly to the ecological variation among islands (see Evans and Lopazanski 1988). Environmental gradients corresponding to topography are largely responsible for the heterogeneity of species composition found within a given maritime forest tract. Forest areas characterized by a dune ridge-swale topography are often characterized by dramatic changes in soil moisture. Swales, being close to the water table and more protected, host a greater diversity of species than dry ridge tops. In swale areas where the ground surface elevation is below the watertable most of the year, a swamp forest community develops characterized by Acer rubrum, Fraxinus tomentosa and Magnolia virginiana. More extensive swamp areas are dominated by a shrub thicket vegetation (Salix and Cornus spp.) rather than trees. Exposure to salt spray and wind shear are also important factors in determining

species composition within a forest. The leading edge of a maritime forest, which forms the transition to the open dunes, has the greatest exposure to these factors and is characterized by a low species diversity and stunted growth forms. This part of the forest is often called the "shear forest".

As will be discussed shortly, natural and man-induced disturbances also contribute greatly to the heterogeneity within a forest. There are many unique transitional plant assemblages associated with the ecotones between the maritime forest and other important barrier island plant communities such as salt marshes, fresh-water marshes and open dunes. These ecotones serve as important wildlife habitats for many animal species whose niches span both community types.

Forest Succession

There have been no published studies on the specific ecological processes associated with the development of maritime forests on coastal dune systems. What is generally known about maritime forest succession has been obtained from observational data only. As initially defined, maritime forests represent an end phase to dune succession. The process of dune succession involves a slow amelioration of conditions that severely limit the growth of plants on dunes such that an environment is produced that can ultimately support tree growth. Primary succession, in general, is usually associated with: 1) the development of a soil structure, 2) an increase in soil nitrogen and 3) an increase in mature plant height (Crawley 1986). The accumulation of soil nitrogen is generally considered the most important rate-limiting factor in primary succession (Marrs et al. 1983, Vitousek et al. 1987).

In coastal dune systems most macro- and micronutrients are supplied to plants on a continuous basis through salt spray (van der Valk 1974; Art 1976; Proffitt 1977; Barbour et al. 1985). Available nitrogen, however, is initially restricted to pockets of rapidly decaying organic material (Evans 1988) or is biologically fixed (Stewart 1967). Inorganic nitrogen leaches quickly through the sand subtrate and is lost to the system. Only with the development of organic soils is there a uniform increase in nitrogen availability. A critical level of nitrogen must be reached in order for a soil to sustain the grow of large-sized organisms such as trees.

Colonization rates and species composition during primary succession depend, to a certain extent, on the proximity of seed sources and seed dispersal agents. Of the three common early tree colonizers of dunes: *Pinus taeda* is wind dispersed, *Quercus virginiana* is mammal dispersed and *Juniperus virginiana* is bird dispersed. The dispersal and colonization events that shape the progress of plant succession are poorly understood for barrier islands and are in need of study. It is not known, for example, whether the limited presence of many common mainland species in

maritime forests is due simply to infrequent colonization events or whether abiotic or biotic factors prevent their establishment once they arrive on a barrier island.

Buxton Woods on Hatteras Island presents a unique opportunity to study martime forest development within the context of dune succession. Since the southern flank of Cape Hatteras has been accreting over the past 1000 years (Fisher 1967), a series of parallel dune ridge-swale systems have been produced whose vegetation span a developmental sequence of dune succession. Studies currently being conducted by one of the authors (Evans) indicate that forest development differs with regard to dune topography and hydrology.

Tree growth and establishment occurs faster within swales. Prior to and during tree establishment, swales are colonized by Myrica cerifera a clonal shrub which is known to host nitrogen-fixing actinorrhizal symbionts (Morris et. al. 1974). It is likely that Myrica cerifera provides a substantial input to the overall biological availability of nitrogen in swales facilitating the early establishment of tree species. (A similar facilitation process has been demonstrated involving Myrica faya on volcanic ash in Hawaii (Vitousek et al. 1987) and has been hypothesized for Myrica pensylvanica in the coastal dunes of New England (Morris et al. 1974)).

Loblolly pine (Pinus taeda) is one of the first tree species to appear in open swales. Once pine forms a closed canopy, Myrica begins to die out and is replaced by a developing understory of Ilex opaca and Persea borbonia (Persea often becomes established concurrently with loblolly pine but grows more slowly). Laurel oak Quercus laurifolia and other hardwoods become established under the protective microenvironment of the pine canopy. Since loblolly pine does not regenerate in its own shade (Chapman 1945), these hardwoods eventually replace the pine as dominants in the canopy.

Dune ridges have a much slower rate of forest development and they are initially colonized by a different set of tree species. Dune ridges present a harsher environment for tree establishment compared to swales. They are characterized by: 1) greater exposure to wind sheer and salt spray, 2) a greater potential for sand erosion and accretion, and 3) lower water and nitrogen availability. Around the same time pine begins to appear in the swales, live oak (Quercus virginiana) and red cedar (Juniperus virginiana) become established on the dune ridges. Young individuals of these two species often appear stunted or "sheared" with finely branched canopies depending on exposure to prevailing winds.

Both live oak and red cedar have been described by Wells (1939) as being tolerant of moderate salt spray. It has been suggested that this tolerance allows these species to survive in exposed areas where other more typical inland tree species would be killed (Wells 1939; Bourdeau and Oosting 1959). These authors

claim that the reason Quercus virginiana is not found inland is that it would be out-competed by faster growing hardwoods, implying a trade-off between competitve ability and salt-tolerance. Although this hypothesis has been widely posited in the coastal literature (e.g., Godfrey and Godfrey 1976), it has never been specifically tested.

The forest that develops on the dune ridges is different from that which develops in the swales, both in terms of species composition and tree morphology. Live oak and red cedar almost exclusively dominate the canopy on dune ridges. These trees tend to have a low stature and are highly branched (partly as a result of low density establishment on the dunes). The loblolly pine and mixed hardwoods in the swales tend to be taller and less branched. These two stand types form a mosaic pattern within the forest corresponding to topographic change. There is generally a mixture of the two different types on dune slopes.

The fate of live oak and red cedar in older, mature maritime forests is not clear. It seems that neither species is able to regenerate successfully in mature, undisturbed forests such as found on Emerald Isle and at Nags Head Woods. It may be that these species are slowly eliminated from the interior of the forest due to an absence of conditions necessary for their recruitment. Competition with other hardwoods may also be an important limiting factor, as suggested by Bourdeau and Oosting (1959). Evidence for either hypothesis is confounded by the fact that both species have been heavily logged from coastal North Carolina forests over the past three centuries.

While there have been no studies of forest development as a part of primary succession, there has been recent research on secondary succession in maritime forests, particularly with regard to disturbance regimes (Bratton and Davison 1987; Evans and Lopazanski 1988). Maritime forests have been historically associated with a high frequency of natural and man-induced disturbance events including: hurricanes, fire, dune migration, grazing and logging. Each of these disturbance regimes can have a unique and dramatic effect on the ecology of a forest. Evans and Lopazanski (1988) have found, for example, that on Shackleford Banks where there has been a long history of feral animal grazing, there are very few trees present in smaller size classes indicating a general lack of recruitment into the canopy. Correspondingly, there is a lower species diversity and tree density on Shackleford Banks compared to nearby Bogue Banks which has not had a recent history of grazing.

Bratton and Davison (1987) found that logging, grazing and fire have significantly altered the species composition and forest structure at Buxton Woods. These three factors contributed to the maintenance of a predominately pine forest, an early stage in forest succession during the past two centuries (Settel 1937). Paleoecological records indicate that Buxton woods was originally an evergreen hardwood forest. With the cessation of these influences as part of the management of Cape

Hatteras National Seashore, Buxton Woods today is succeeding to hardwoods once again.

Vegetative patterns on Bear Island are controlled by migrating sand dunes. There is a patchwork of successional stages present on the island. No patch is left undisturbed from burial long enough to develop an intact forest cover. The original forest that was present over much of the island a century ago, has been reduced substantially by burial and continues to be buried further each year. Increased forest development on Bear Island depends on the extent to which the migrating dune systems become stabilized in the future. Migrating sand dunes are also an important factor affecting the distribution and development of maritime forests on Shackleford Banks and at Nags Head Woods.

Maritime forests have the capacity, like most forest communities, to regenerate following natural or human disturbances provided that these disturbances are not permanent in nature. Substantial habitat alteration occurs following episodes of hurricane damage, logging or grazing, but the natural processes of recolonization and regrowth will eventually reconstitute a forest, given enough time. (The actual rates of maritime succession following disturbance have never been studied.) However, the removal of forests and other barrier island plant communities through large-scale clearing and commercial development results in a net loss of potential and realized maritime forest habitat. It is this process of fragmentation and removal associated with development that has led to the dramatic decline of maritime forests on our coast over the past 30 years.

Conservation Biology

One of the important facts we are only now beginning to realize about maritime forests is that they are particularly susceptible to the deteriorating effects of fragmentation. This is largely due to the severe environmental conditions under which they exist. Patches of maritime forests that are left in areas that have been partially cleared for development, rapidly deteriorate due to the sudden exposure to salt spray, wind shear, altered drainage, the invasion of weedy species and other factors. Much of the forest on Bogue Banks has been lost as a result of this fragmentation process (Lopazanski 1987). Substantially larger areas than one would normally leave inland, must be left intact during development if the ecological integrity of a maritime forest stand is to be maintained.

Habitat loss associated with the fragmentation process often occurs as a result of the "edge effect." When permanent clearings are suddenly created surrounding a forest stand, there can be dramatic changes in the microclimate of the forest perimeter such as increased intensities of light, salt spray, thermal radiation and dry winds. These factors alter the

vegetation in a belt of microclimatic change along the edge of the stand. Depending on exposure, this belt of change or edge effect can cause the mortality of many tree species and allow the invasion of weedy alien species. The die-back of live oak along NC 58 on Bogue Banks is an excellent example of this edge effect phenomenon. In smaller fragments, the edge effect can extend into the center of a maritime forest stand, completely altering its ecology.

The shear forest which forms at the leading edge of the maritime forest, at the transition into open dunes, is a result of long-term, gradual vegetative response to naturally created edge conditions. The canopy of the shear forest abuts the top of the rear dune, forming a protective closed covering over the forest understory. On Shackleford Banks, feral animals have created a browse line along this normally closed forest edge, exposing the forest interior to dry winds, increased salt spray, etc.. This process, in combination with severe overgrazing has contributed to a decline in forest species diversity on Shackleford Banks (Evans and Lopazanski 1988).

The edge effect can therefore lead to a further shrinkage of forest fragments and a loss of component maritime forest species. Fragmentation itself brings about a loss of continuity with other forest areas and with other habitat types. This is a critical loss to animal species that depend on the maintenance of forest transition areas for their survival. Fragmentation isolates forest populations by resticting dispersal and preventing gene flow. This can ultimately lead to increased homozygosity and a build-up of lethal recessive genes within a population (Soule 1986). By being located on islands, maritime forests are already isolated to a certain degree. Fragmentation dramatically compounds the ecological effect of this isolation by essentially creating islands of forest within islands. The shrinking of forest size increases the ecological effect of disturbance events. For example, the effect of a hurricane on a large stand may be the formation of gaps in the canopy while the same storm by partially if not entirely destroyed a small stand. The same arguments hold true for grazing, fire, and other disturbances.

It is not known how large an area of maritime forest habitat is required to maintain viable populations of any of the component plant or animal species. This is difficult information to obtain, especially since most species are dependent on other species for survival. For example, oaks and hickories are dependent, to a certain extent, on squirrels for the dispersal of their seeds. One might ask the following question: what is the critical forest habitat size necessary to maintain a viable population of squirrels that will adequately disperse the seeds of oaks and hickories, maintaining viable populations of these species as well? No data are currently available to answer this type of question.

Forest clearing and filling of wetlands can alter the hydrology of a maritime forest and even the hydrology of an

entire island. Maritime forests serve to protect and recharge freshwater aquifers that develop within barrier islands. These aquifers often are the sole source of fresh water for the inhabitats of an island and so their protection is vital.

Finally, it is important to point out that much of the information presented here on conservation biology is theoretical. It is based a working knowledge of the limited information available for maritime forests. There have been no specific studies published pertaining to the conservation biology of maritime forests. Extensive research is needed, therefore, in such areas as the determination of critical habitat sizes and the mean viable population numbers of important maritime forest species so that management recommendations can be based on a more complete scientific foundation. Unfortunately, the pace of maritime forest destruction in this state far exceeds the pace of scientific research. It can not do for managers to sit back and wait for additional scientific information. Actions must be taken now, based on what we <u>do</u> know, to prevent further loss of maritime forest habitat.

Part II: Management of Maritime Forest in North Carolina

Introduction

The location of many of the oldest villages along the Outer Banks attest to the fact that original colonists were drawn to the beauty and protection of the maritime forests. Early settlements such as Old Nags Head, Ocracoke, Portsmouth, and Diamond City were established within these island "oases." It was within the maritime forests that early settlers found homesites that were less susceptible to flood waters, high winds, and harsh temperatures. Abundent shell middens provide evidence of even earlier use of these areas by Native Americans.

Maritime forests were not preserved by these early inhabitants; on the contrary, over the years these areas were subject to a high frequency of man-induced disturbances such as fires, logging, and grazing of animals. Fortunately, like most forest communities, maritime forests have the capacity to regenerate following human or natural disturbances provided that these disturbances are not permanent in nature. However, as more and more of the forests are subdivided into developed lots, the impact of human disturbance will be cummulative and largely irreversible.

Maritime forests can and should be managed in a manner that avoids or minimizes harmful impacts to the ecosystem. This protection can best be achieved through the implementation of the following measures:

1. Preservation through public acquisition (federal, state, or local government) or by conservation organizations.

2. Enforcement of federal and state environmental regulations.

3. Resource management through designation as an Area of Environmental Concern (AEC) by the N.C. Coastal Resources Commission.

4. Resource management through local government zoning.

5. Conservation through development policies and land classifications prescribed in the local land use plan.

6. Conservation through landowner's voluntary protection. (Possible registration with the NC Natural Heritage Program as a protected natural area.)

These options vary in their ability to protect the resource depending on the level of authority (federal, state, or local), the effectiveness of the regulations in controlling the loss of critical resources, the enforcement of those regulations, and the landowner's desire to protect the area in lieu of government regulations.

Federal and State Management

The most effective strategy in terms of providing the greatest amount of protection is to purchase significant areas of maritime forest and preserve them as natural areas. However, public acquisition depends on the availability of funds and a willingness on the part of the landowner to sell or donate his or her land. Other, less costly alternatives include bargain sales, conservation easements, and land donations.

In the late 1970s the N.C. Nature Conservancy acquired 360 acres of Nags Head Woods, now managed (along with 350 acres owned by the town of Nags Head) as an ecological preserve. Another example of maritime forest preservation was the purchase of almost 1,000 acres of Buxton Woods by the federal government for inclusion in the Cape Hatteras National Seashore. The State of North Carolina is currently adding to this effort by purchasing key portions of the privately owned forest (330 acres so far) and preserving them as natural areas within the North Carolina Coastal Reserve. The incorporation of Shackleford Banks in the Cape Lookout National Seashore took this protection option one step further by acquiring a complete maritime forest system (as well as the entire island), rather than just a portion of the forest as in the case of Nags Head Woods and Buxton Woods. Shackleford is managed as a wilderness area by the National Park Service.

Federal protection for fresh-water wetlands, an important component of maritime forest ecosystems, is provided under section 404 of the Clean Water Act. The U.S. Army Corps of Engineers is responsible for granting or denying permits to discharge dredged or fill materials into wetlands. According to the Corps' definition, areas of maritime forest that fall under its jurisdiction are "those lands that are innudated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions." Since most maritime forests are interlaced with various sized wetlands, this measure has the potential to be an effective regulation of destructive development practices in maritime forest areas. Unfortunately, enforcement of the 404 wetlands regulations is a problem; the Corps regulatory branch is understaffed which means that the filling of smaller, isolated wetland areas often goes undetected. In addition, there is a high degree of subjectivity involved in the wetlands delineation process, allowing it to be influenced by nonscientific criteria. Furthermore, because the tremendous increase maritime forest property values in recent years, it is not inconceivable that developers could incorporate 404 wetland violation fines into development costs and pass it on to the buyer. Finally, the lack of regulatory jurisdiction over certain dredging activities within maritime forests is a also significant shortcoming.

There is a clear mandate implicit in the North Carolina Coastal Area Management Act (CAMA) of 1974 (N.C.G.S. 113A-100 et

seq.) for the protection of maritime forest resources. The primary goal of CAMA is: " to provide a management system capable of preserving and managing the natural ecological conditions of the estuarine system, the barrier dune system and the beaches, so as to safeguard their natural productivity and their biological, economic and esthetic values" (Section 113A-102(b)(1)). State protection for maritime forests would be available if the N.C. Coastal Resources Commision (CRC) were to designate maritime forests as "areas of environmental concern" (AECs). CAMA authorizes the CRC to manage development in AECs by requiring that development within these areas be consistent with standards designed to protect critical coastal resources. While we have general AEC categories covering the estuarine system, public trust waters and beaches, there is currently no uniform category regulating development in the maritime forest ecosystem, even though it is a important component of the barrier dune system as specifically covered under CAMA.

The CRC could decide to create a new maritime forest AEC category and establish management objectives and general use standards for new development proposed within the AEC. This would be a preferred option over the designation of specific areas on an independent basis, since a set of uniform state standards would provide the most comprehensive regulation and would the most fair since since no one forest area would be treated differently from another.

Individual forest sites, however, can be given AEC designations under the existing Natural and Cultural Resource category, if they are judged to be a unique natural area of statewide significance. One such area, Buxton Woods, a 3,000-acre maritime forest on Hatteras Island was nominated under this special AEC category in 1986. Over the following two years, the CRC considered an AEC designation for Buxton Woods (the state's largest maritime forest). Its designation would have set a precedent for future maritime forest AECs elsewhere on the coast. However, in March 1988, Dare County adopted a strict zoning ordinance, similar to the AEC standards, designed specifically to protect the Woods. Satisfied that adequate protection for the Woods was now available through local land use regulations, the CRC decided to table the Buxton Woods AEC proposal. A recently expanded water supply AEC in the woods and a new state initiative to purchase key portions of the forest also played key roles in the CRC's decision. To date, Dare County has taken a cautious approach in implementing its ordinance. Zoning, however, by its nature is an ephemeral form of land management, easily changed by political and economic pressures. It does not have the lasting regulatory enforcement provided by a CAMA AEC designation.

Local Management

As evident in the outcome of the Buxton Woods issue, limited protection of maritime forest areas can be achieved through local government policies and regulations. Local zoning ordinances and

land use plans can be effective tools for managing these environmentally sensitive areas. Whereas state and federal regulations can provide generic standards to protect certain categories of fragile resources (e.g., coastlines, wetlands, public trust waters), local governments have the authority to adopt and enforce stricter development regulations. Moreover, local regulations can be tailored to protect resources that are unique to a particular area. As stated above, the problem with local regulations is that they are subject to change depending on the attitude of the current town or county administration. Also, variances can be granted with little opportunity for public notification and comment.

Land use plans provide local leaders with an opportunity and responsibility to establish policies that will guide the development of their community. In North Carolina under the auspices of CAMA, each of the coastal counties and municipalities are encouraged to develop a land use plan which includes, among other things, policy statements on a number of resource protection issues. While these policies reflect the local goals and development priorities with regard to the protection of fragile resources, they are generally not considered enforceable regulations. Local ordinances need to be adopted in order to implement the various policies. (Part III of this report includes a discussion of the local maritime forest protection policies for each forest site surveyed.)

Local ordinances that are intended to protect the maritime forest ecosystem should include provisions designed to keep building density as low as feasible, thus allowing the greatest amount of forest to remain intact. Roads and utility lines should follow natural contours; freshwater ponds should not be dredged, filled, or otherwise altered; and trees should only be cut if they interfere directly with home construction and access. Limiting the percentage of the lot which may be cleared and using only native shrubs for ornamentation and stabilization will also help in maintaining the natural forest vegetation. Setbacks can also be helpful to buffer wooded areas from encroaching development. Finally, it is important that only those uses that will have the lowest environmental impact be allowed in forested areas. These uses may be limited to single family residential housing, clustered housing, watershed conservation areas, and compatible recreational uses. (See Table 1 for a summary of current local protection measures in North Carolina maritime forests.)

Presently, the level of resource protection associated with clustered housing versus detached housing units is still in question. Scientist do not know if concentrating development in one area will have less of an impact on maritime forests (in terms of increased light, wind, and salt spray) than scattering the development on more evenly spaced parcels, say half-acre or one-acre lots.

As discussed in Part I, the greater the density of development allowed, the more the forest will become fragmented. There is a minimal area at which a forest fragment is still capable of maintaining itself in terms of seedling recruitment into the canopy population. There is also a minimum area which will support the same number of plant and animal species as would a comparable area of undisturbed forest. Below this minimum size, species will be lost, and those still present may no longer be capable of replacing themselves. The loss of species and individuals will continue until the forest fragment no longer retains any of its original character.

Unfortunately this theoretical "minimum area" is site specific and depends upon a variety of environmental conditions. Since in practical terms it is often necessary to specify an ecologically sound minimum area, it is best to err on the safe side and allow a very wide margin of buffer between clearings. As a rule, lot sizes of 80,000 sq. ft. should be considered a lower limit in any forest site. (See Table 1 for a comparison of existing local protection measures for maritime forests.)

TABLE 1

Comparison of Existing Local Protection Measures for Maritime Forests

Forest Area (Local Gov't) / Resource Protection	Currituck Bks. (Currituck Co)	Kitty Hawk Wds. (Kitty Hawk)	Nags Head Woods (Nags Head)	Colington (Dare County)	Roanoke Island (Manteo)	Buxton Woods (Dare County)	Shackleford Banks/Bear Island	Atlantic Beach	Indian Beach	Emerald Isle	Huggins Island (Swansboro)	Surf City	Bald Head Island
Density Restrictions	30,000 ft^2	80,000 ft^2	80,000 ft^2	5,500 ft^2	15,000 ft^2	40,000 ft^2	NA	7,000 ft^2	15,000 ft^2	12,500 ft^2	40,000 ft^2	5,000 ft^2	10,000 - 15,000 ft^2
Maximum % Lot Disturbance						20-35%		65%	60%	65-85%		75%	
Limits on Tree Removal													
- encourage min. cutting	X	X	X		X	X		X	X	X	X	X	X
- clearing only for building site, access, etc.		X	X			X							X
- tree size/distance from structure			>4-16"						>1"	>4"			
Development Setbacks													
- side, front, rear		X	X		X	X		X					
- wetlands		50'	50'			50'		10-35'					
- dune ridge			X					35'					
Structure Height Limit	35'	below canopy	35'	35'	35'	35'		35'	35'	35'		35'	
Dredge/Fill Wetlands Regs.		X	X		X	X				X			
Grading Restrictions		X	X		X								
Road Width Limitations						X							
Constr. of Parking Area			X			X							
Restrict Sand Removal			X			X							

Part III: Maritime Forest Assessment By Island

Introduction

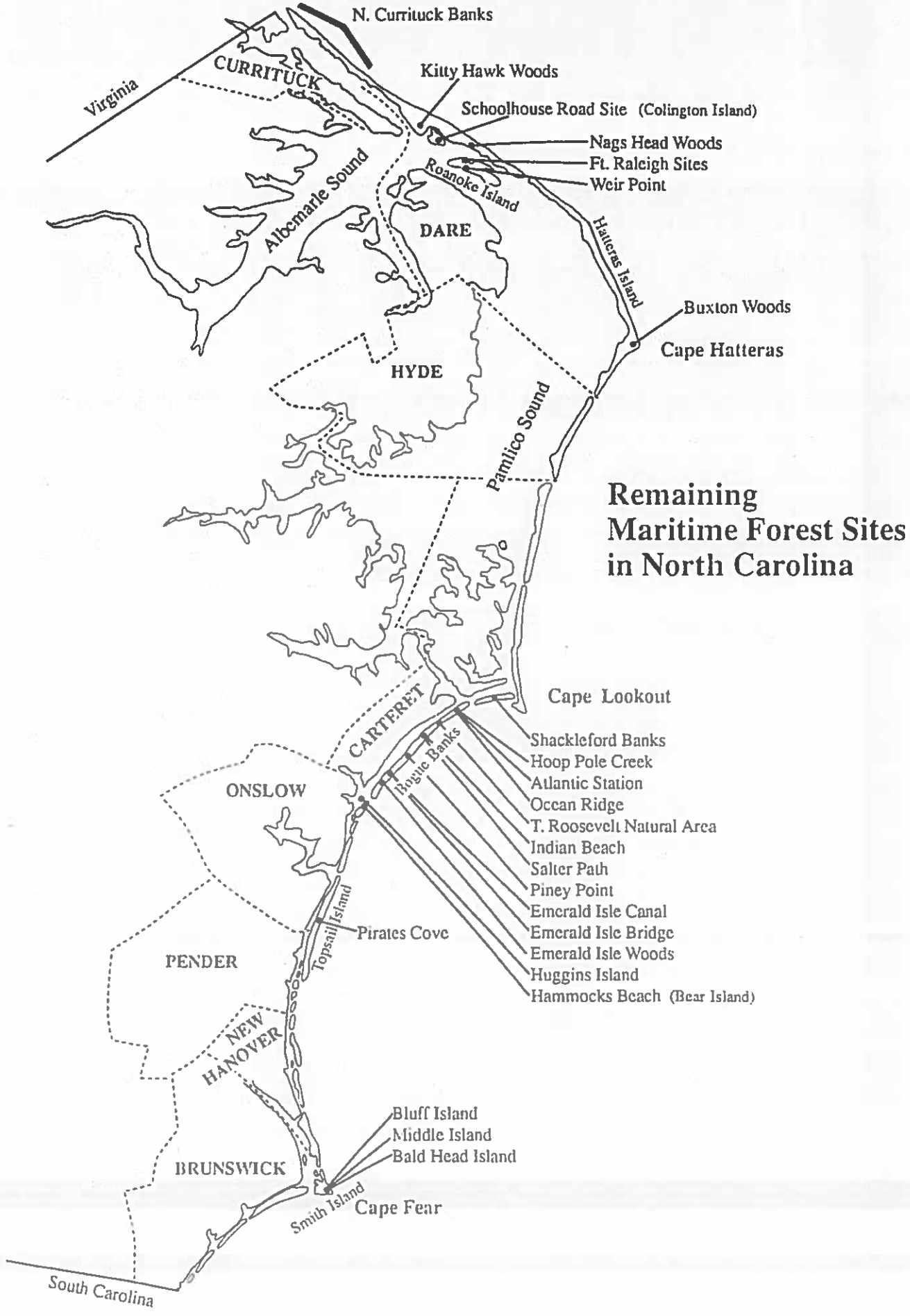
A total of 24 forest areas were surveyed on 16 barrier islands in North Carolina (see Fig. 1). Potentially forested areas were first identified from large-scale aerial photos. Field trips were then made to each of these areas to verify the existence of intact forests. Each site was described from an ecological standpoint, surrounding land uses were recorded and boundaries of the intact forest areas were delineated. Tax records were then used to compile a list of landowner names and addresses, as well as acreages for each surveyed parcel (see Appendix C). While, only those tracts greater than 20 acres were generally considered, some smaller tracts of particular interest were also included.

The site information was recorded in the form of short, detailed site reports. These reports (available from the authors) contain the following information for each forest site:

- -a general ecological description
- -significant natural features
- -topographic relief
- -soil type and profile
- -site integrity (degree of disturbance)
- -successional status
- -characteristic community type
- -threats to ecological integrity
- -current management (zoning, etc.)

The history of land use in the maritime forests of each island was obtained from the literature, town halls, and personal communications, and is described in the forest site summaries. Current forest management information was gleaned from local zoning ordinances and land use plans and was incorporated into the following forest site summaries.

This report presents a complete inventory of all maritime forest tracts remaining in North Carolina, greater than 20 acres in size. Such an inventory thus constitutes a delineation of the maritime forest ecosystem as it exists today in the state of North Carolina. The report, however, does not address potential or unrealized maritime forest habitat.


N. Currituck Banks
CURRITUCK
Virginia
Kitty Hawk Woods
Schoolhouse Road Site (Colington Island)
Nags Head Woods
Ft. Raleigh Sites
Weir Point
Roanoke Island
Albemarle Sound
DARE
Hatteras Island
Buxton Woods
Cape Hatteras
HYDE
Pamlico Sound
Remaining
Maritime Forest Sites
in North Carolina
Cape Lookout
CARTERET
Shackleford Banks
Hoop Pole Creek
Atlantic Station
Ocean Ridge
T. Roosevelt Natural Area
Indian Beach
Salter Path
Piney Point
Emerald Isle Canal
Emerald Isle Bridge
Emerald Isle Woods
Huggins Island
Hammocks Beach (Bear Island)
Bogue Banks
ONSLOW
Topsail Island
Pirates Cove
PENDER
NEW HANOVER
Bluff Island
Middle Island
Bald Head Island
BRUNSWICK
Smith Island
Cape Fear
South Carolina

CURRITUCK BANKS

History of Forest Use

Currituck Banks extends from Oregon Inlet, north to the Virginia line. Prior to 1800, several inlets cut across the island until the last one, Caffey's Inlet (New Currituck Inlet), closed around 1828. The closing of this inlet cut Currituck Sound off from ocean influences resulting in a shift from brackish to fresh water and a drastic alteration in the sound's aquatic life (Pilkey et al. 1980).

Three major forested areas exist on Currituck Banks. These areas are Nags Head Woods, Kitty Hawk Woods, and a long, narrow fringe of woodlands on the sound side of northern Currituck Banks. Each of these areas is quite different from the others, both physically and floristically, and are described in detail in the site summaries which follow.

Nags Head was originally purchased in the early 1830s by a planter from Perquimans County with the intention of building a summer residence there. By the 1840s, the planter had sold much of his original land holdings to other mainland residents for summer residence construction. A hotel was eventually built and Nags Head slowly became one of North Carolina's first coastal resorts (Stick 1958). The original summer residents built their homes on the sound side of the island, just south of the permanent resident community located in Nags Head Woods.

According to a National Park Service timber survey conducted in 1937, there were approximately a dozen farms located in the Nags Head Woods area which were ten acres or less in size (Settel 1937). Settel (1937) also reports that heavy logging in the Woods during the 1920s resulted in the removal of most of the merchantable timber.

Presently, much of the Woods is intact, approximately 700 acres are owned and managed by the North Carolina Nature Conservancy and the Town of Nags Head. The edges of the forest, however, are being encroached upon by surrounding development which includes property in the southwest corner of the Woods (300 acres), which is currently being subdivided.

Kitty Hawk Woods is located approximately five miles north of Nags Head Woods. The village of Kitty Hawk was fairly well populated by the 1700s, with most of the population taking up residence on the sound side of the Woods. The primary occupation of the inhabitants was farming and fishing, but by 1950, the community had spread to the beaches and had become a resort, similar to Nags Head (Stick 1958). Settel (1937) noted in a timber survey of the Kitty Hawk Woods that free-range grazing (pre-1937) had resulted in considerable damage to the forest vegetation. Young trees had been heavily browsed by cattle, and seedlings and saplings were destroyed by the rooting activities

of hogs. Heavy logging in the area around 1900 eliminated most of the mature trees (Settel 1937).

Until recently, development has been restricted to the beaches and higher elevations on the sound side of the island, leaving the forest mostly intact. However, increased demand for maritime forest home sites has resulted in major subdivisions within Kitty Hawk Woods. The edges of the forest are currently the site of new housing and other development resulting from a recent zoning change from residential to commercial.

The area of Currituck Banks north of Duck has always been sparsely populated due to its relatively low profile and frequency of inlet openings and closures (Pilkey 1980). A relatively large portion of this area is protected as the Audubon Society Pine Island Sanctuary (4,158 acres) and the Currituck Shooting Club property (2,100 acres are managed for hunting). Development on Currituck Banks has increased in recent years, including both clustered beach cottage communities and larger residential communities on the sound side of the island. Although the seaward portion of the island is sparsely vegetated, and is dominated by shifting dunes (set in motion by recent anthropogenic disturbances), the lee side of the island has a long narrow fringe of forest which is being rapidly developed in the vicinity of Corolla.

FOREST SITE SUMMARY

Island: Currituck Banks
Site Name: N. Currituck Banks
Acres: > 5,000 acres
County: Currituck
Site Number: 1
USGS Quad: Barco

Location and Directions

This site starts at the northern limits of Highway 12 at the Dare/Currituck County line. The forest is a discontinuous narrow fringe which runs along the sound side of the island to the Virginia border. (See Fig. 2)

Site Description

The topography of the site is relatively flat with isolated dunes. There is no apparent dune ridge system within the forest. Near the sound, where salt spray effects are at a minimum, a Quercus virginiana scrub forest begins to replace the grassy flats found closer to the beach. Co-dominant with the live oak is Myrica cerifera. Pinus taeda begins to mix with the live oak closer to the sound but no real canopy forms until approximately 100-500 meters from the sound. In this area, swamp forest influenced by the brackish-fresh waters of Currituck Sound is common. The swamp forest canopy consists of Acer rubrum, Liquidambar styraciflua, and Pinus taeda

Evidence of Disturbance

The northern section of Currituck Banks is now rapidly being developed with individual beach cottage communities and larger residential communities on the sound side of the island especially in the vicinity of Corolla. This development has resulted in considerable clearing of parts of the maritime forest fringe. Shifting dunes, set in motion by recent anthropogenic disturbances, are also having some affect on forest cover.

Ecological Significance

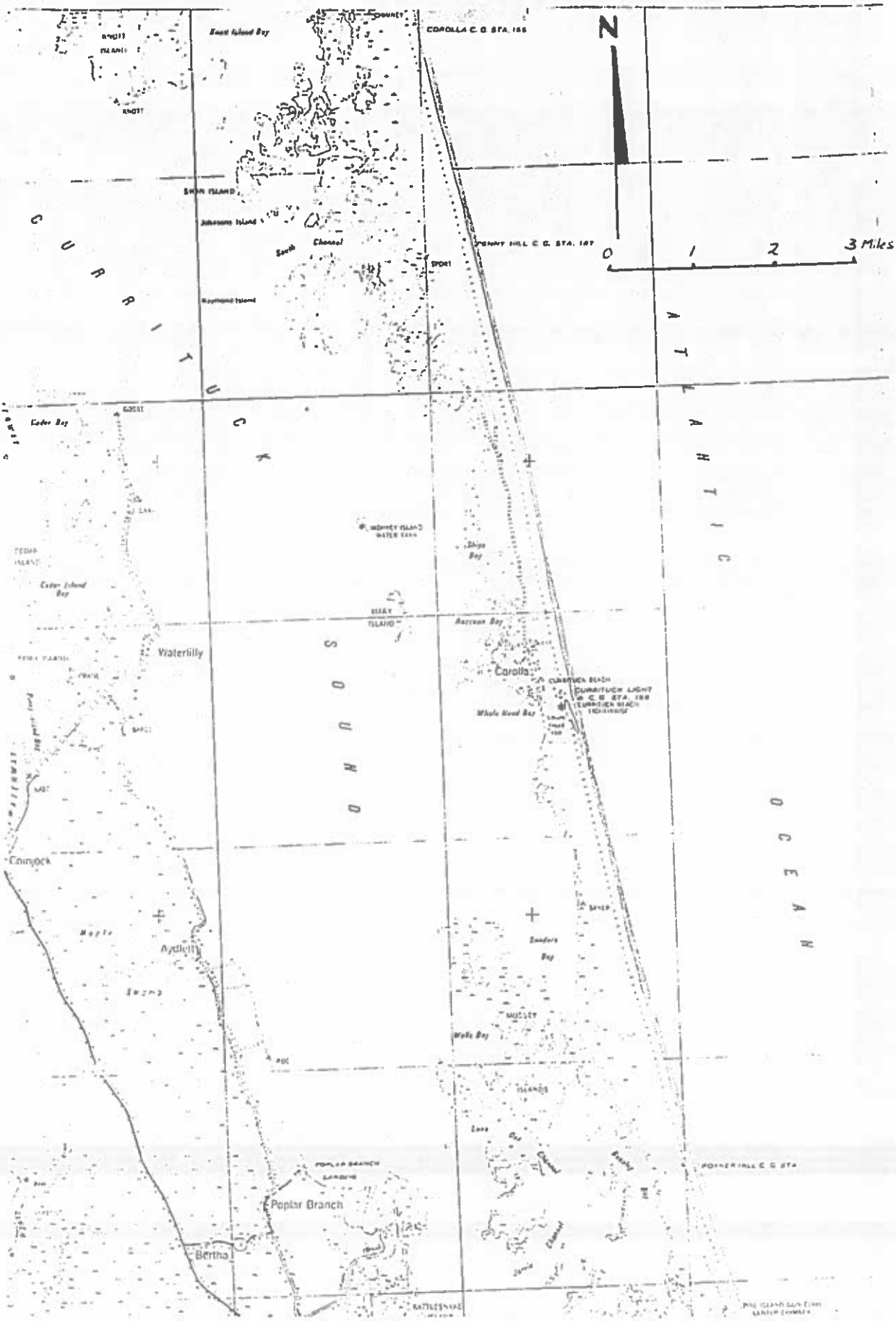
Due to the lack of nearby inlets and ocean influences, the northern portions of Currituck Banks possess a wetland habitat that is unusual on the Outer Banks. Instead of a live oak forest bordering the sound, the area is dominated by red maple and sweet gum. The island's sound side profile resembles that of a lake shore because of the lack of salt spray. According to the NC Natural Heritage Program, this area provides a wintering habitat for more than 15% of the migratory water fowl using the Atlantic flyway.

Current Forest Management

There are no state or local government policies pertaining to the protection of forest vegetation on northern Currituck Banks (other than state regulations governing destabilization of the dunes). The minimum lot size in this area of Currituck County is 30,000 square feet. There are no restrictions, however, regarding the removal of vegetation. A relatively large portion of this area is protected as the Audubon Society Pine Island Sanctuary (4,158 acres) and the Currituck Shooting Club property (2,100 acres managed for hunting).

FIGURE 2

Currituck Banks: Forest Site #1 - Northern Currituck Banks



FOREST SITE SUMMARY

Island: Currituck Banks
Site Name: Kitty Hawk Woods
Acres: 540 (undisturbed)
1900 (total)

County: Dare
Number: 2
USGS Quad: Kitty Hawk

Location and Directions

The eastern border of Kitty Hawk Woods is US 158 Bypass and the associated development. The northern boundary is delineated by a power line cut, the western boundary is Currituck Sound, and the southern boundary is SR 1206 (Kitty Hawk Rd.). This forest site is accessible via sand roads off US 158 Bypass in Kitty Hawk. The interior of the tract is reached by taking SR 1206 (Kitty Hawk Rd.) to Main Rd. which bisects the tract. (See Fig. 3)

Site Description

Kitty Hawk Woods is situated on the widest part of Currituck Banks. The topography consists of low, gently rolling dune ridges (2-3 meters in height) with low wet swales in between. These dune ridges run parallel to the shoreline.

The area on the east side of Main Rd. (540 acres) is relatively undisturbed. The dominant canopy species on the dune ridges are Quercus falcata, Quercus nigra, Quercus phellos, and Fagus grandifolia. Also present in the canopy are Carya glabra, Nyssa sylvatica, and Pinus taeda. These species are represented mostly by scattered, mature individuals. This is especially true of Pinus taeda. The common species in the wetland swale areas are Acer rubrum, Liquidambar styraciflua, and Nyssa sylvatica. The understory contains abundant Cornus florida, Persea borbonia, Ostrya virginiana, Sassafras albidum, and Carpinus caroliniana. Other species present in the understory layer are smaller individuals of Ligidambar styraciflua and Acer rubrum.

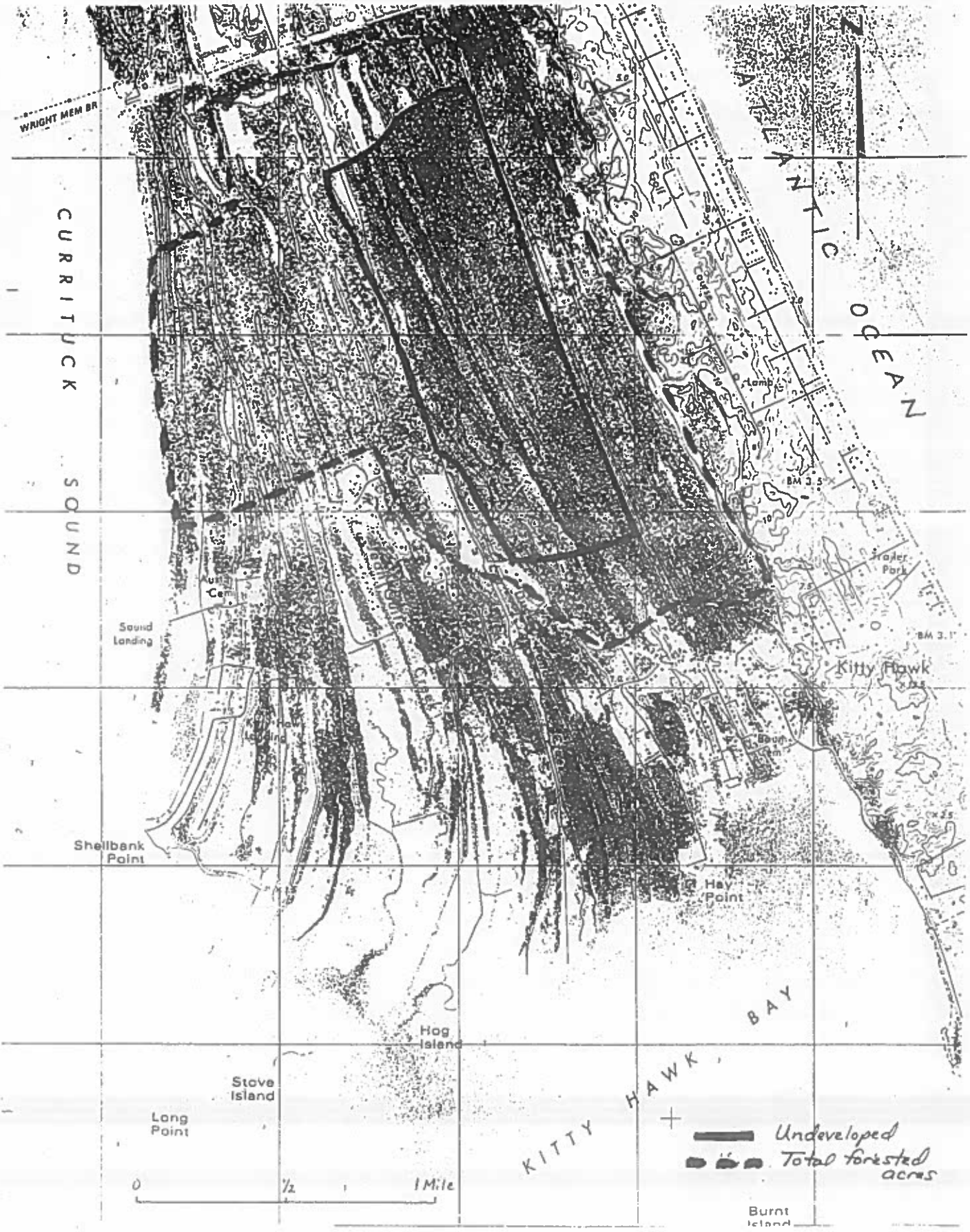
The ground cover of the ridges consists of Mitchella repens, Calicarpa americana, Berchemia scandens, Parthenocissus quinquefolia, Conopholis americana, and Arundinaria gigantea. Common cover in the low lying swale areas are Asplenium platyneuron, Saururus cernuus, and Woodwardia aerolata. Stands of Taxodium distichum are found in the eastern sections of the Woods where the swales are broader. This area runs parallel to a power line cut.

Evidence of Disturbance

The 540 acre tract is presently undeveloped, but has been subdivided into 10-acre lots. The area on the west side of Main Rd. has been subdivided similarly. This area, however, has a paved road and lots that have been cleared of shrub and understory vegetation. Further west, near the sound, the forest has been subdivided into three-acre lots and homes are currently being built. The area surrounding the undisturbed 540-acre tract (see Fig. 3) has had a history of light development. Along southern SR 1206 there is a borrow pit which occupies approximately 30 acres of land.

FIGURE 3

Currituck Banks: Forest Site #2 - Kitty Hawk Woods



Ecological Significance

The Kitty Hawk Woods is the largest area of maritime forest on the North Carolina coast composed of species more typical of northern maritime forests. The forest also contains southern elements as well as a number of rare species such as Listera australis. Kitty Hawk Woods is the only forest site containing stands of Bald Cypress. Kitty Hawk Wood's ecological significance lies mainly in its size, lack of disturbance and extensive forest wetlands. These attributes also make it an important wildlife refuge.

Current Forest Management:

Located within the town of Kitty Hawk, Kitty Hawk Woods is one of the three largest maritime forests remaining on the North Carolina coast. The forest has extensive wetlands, which due to their protected status, make much of the area unsuitable for development. For this reason, a large part of the forest, known locally as Kitty Hawk Woods, is classified in the town's land use plan as "Conservation Lands." The Town of Kitty Hawk believes that these lands require long-term management in order to protect their irreplaceable natural values. One major value of the forest noted by the Town, is its role in the ground water replenishment cycle. Therefore it is Town policy that these lands be limited to low density residential, recreational, and open space uses.

The Town has zoned a large portion of the forest (approximately 1500 acres) as Kitty Hawk Woods District. This zoning encourages only that development which is "compatible with the environmentally sensitive nature of the forest". Permitted uses under the Kitty Hawk Woods District zoning are low density residential development, watershed conservation areas, and wildlife and ecological preserves. A minimum lot size of 80,000 square feet of buildable land is required for residential development. Recently, the majority of the forest was subdivided into 10-acre lots, which, due to the extensive wetland swales within the area, was necessary to meet the required 80,000 square feet of buildable land.

Before construction can take place in Kitty Hawk Woods, a site plan must be submitted with a description of the existing vegetation, including forest canopy, sub-canopy, scrub forest, ridge line trees, rare plants, and ground cover species. Prior to building site approval, the Town takes these natural features into consideration so that the permitted construction will cause the least disruption of the forest.

While the Town's policies go beyond merely protecting the aesthetic values of its forests, these policies have not been implemented rigidly on the perimeter of Kitty Hawk Woods. For example, along US 158 Bypass, there is a forested area with a large amount of buildable land, for which the zoning has been changed frequently in order to permit commercial uses. Similar areas with buildable land within the forest interior are also being developed. Some of these areas have undergone substantial

amounts understory clearing, apparently to provide a more open appearance to prospective lot buyers. Although the Town is maintaining its 80,000 square foot requirement, the forest habitat is none-the-less being altered and slowly encroached upon.

FOREST SITE SUMMARY

Island: Currituck Banks
Site Name: Nags Head Woods
Acres: 755

County: Dare
Site Number: 3
USGS Quad: Manteo/ Kitty Hawk

Location and Directions

Nags Head Woods is located along the west side of US 158 Bypass in Nags Head and Kill Devil Hills. The Woods are accessible by several sand roads off US 158 By pass, or Ocean Acres Dr., which leads to the Nature Conservancy Nags Head Woods Ecological Preserve. The eastern boundary of the forest includes residential housing subdivisions in both Nags Head and Kill Devil Hills. The western forest boundary is a sand road which runs along the extensive marshes of Albemarle Sound. The northern boundary is a migrating dune field located in the town of Kill Devil Hills. The dune front is approximately 15 meters high and is encroaching on the forest. The southern boundary is a residential subdivision of the town of Nags Head. (See Fig. 4)

Site Description

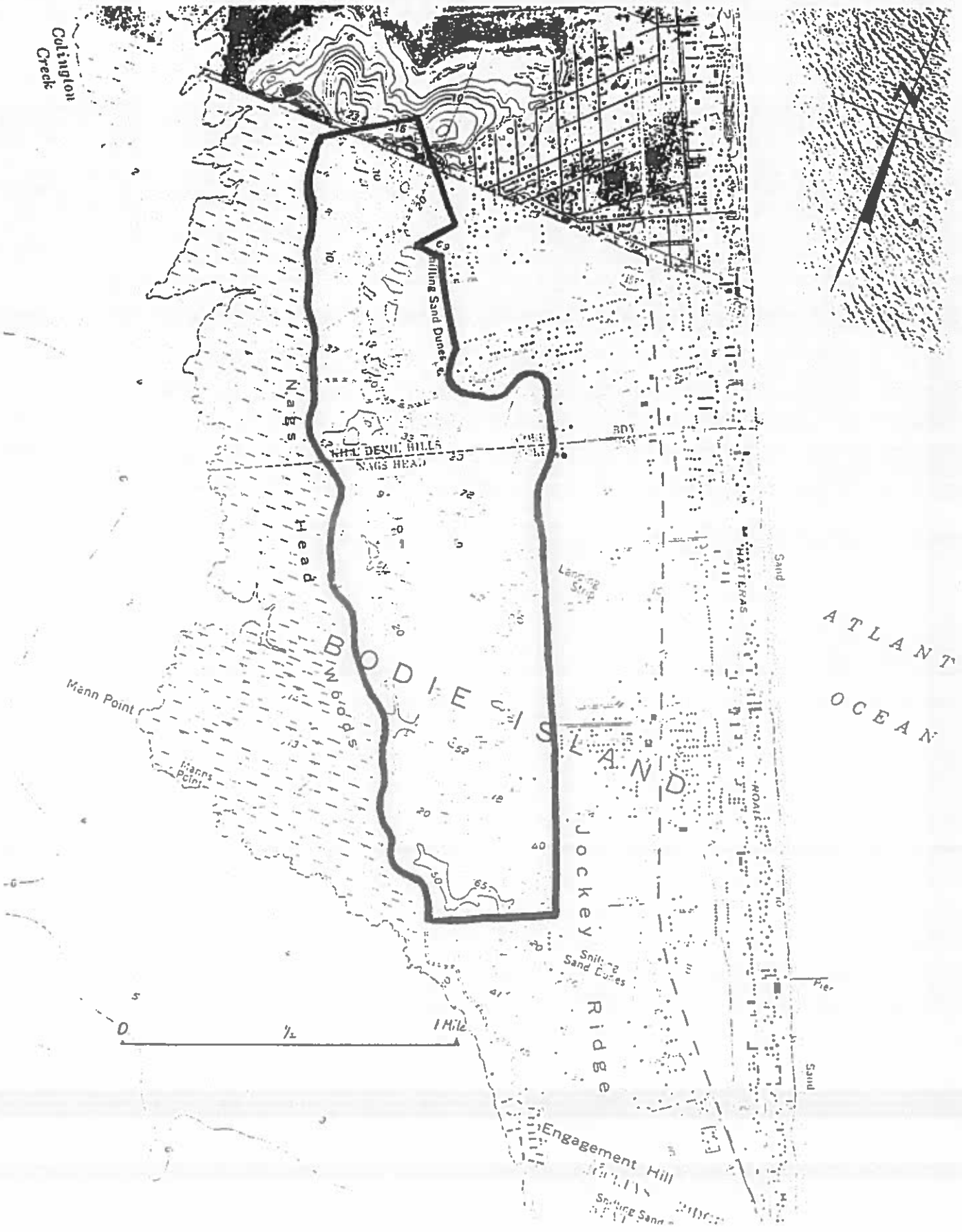
The topography of Nags Head Woods is characterized by large dune ridges up to 20 meters in height, and low lying swales. The dune ridges are steep and not widely spaced. The most abundant canopy species on the drier dune ridges are Pinus taeda, Quercus falcata, Quercus laurifolia, and Carya tomentosa. The most abundant understory species in these areas are Cornus florida, Persea borbonia, Carpinus caroliniana, Ostrya virginiana, Ilex opaca, and Sassafras albidum. Quercus virginiana and Juniperus virginiana are noticeably absent from most of the forest and only occasionally found on some of the higher dune ridges. In general, the canopy height ranges from 25-30 meters in the swale areas and 5-7 meters on top of the ridges.

The low lying swale areas are dominated by swamp forest species which often have large buttresses and other adaptations for standing water conditions. These species include Liquidambar styraciflua, Acer rubrum, and Nyssa sylvatica. Some of the drier swales contain populations of the significantly rare Listera australis and the uncommon Cypripedium acaule. Most of the swales in the eastern and central sections of the Woods are close enough to the water table to form interdunal ponds. The largest of these ponds (Fresh Pond) serves as the primary fresh water source for the Town of Nags Head. Most of the ponds have open water year round and support emergent and floating aquatics.

The ground cover of the woods varies with topography and moisture regime. The wetter sites support the ferns Asplenium platyneuron, Pteridium aquilinum, and Woodwardia areolata. Also found in the wetter areas is Myrica pensylvanica. Other ground cover species include Mitchella repens, Smilax bona-nox, Smilax rotundifolia, Smilax laurifolia, Berchemia scandens, Vitis aestivalis, Vitis rotundifolia, Rhus radicans, Parthenocissus quinquefolia, and Rubus trivialis.

FIGURE 4

Currituck Banks: Forest Site #3 - Nags Head Woods



Evidence of Disturbance

Several sand roads run through the area which are not under the control of The Nature Conservancy. In addition to small dump sites, the roads are commonly used by ATV riders who gain access to paths through the Woods. The margins of the Woods are heavily impacted by the surrounding development in terms of trash and vegetation disturbance. The Town of Nags Head operates a sewage treatment facility within the Woods.

Ecological Significance

Nags Head Woods is the third largest tract of maritime forest remaining on the North Carolina coast. Although the Nags Woods area has a low diversity of plant species when compared to mainland forests, it maintains the highest diversity of vegetation of all maritime forest on the Outer Banks. The Woods has many species associations, such as the co-occurence of Quercus falcata and Carpinus caroliniana, which are unique to the area. These associations can be attributed, in part, to the diversity of topography and habitat types found in the Woods.

The interdunal ponds and associated wetlands add to the diversity of the forest, offering many opportunities for research concerning the ecology of the ponds and how they function with the surrounding forest. Nags Head Woods is also habitat for several endangered and usual plant species including Hudsonia tomentosa, Listera australis, Hottonia inflata, Wolffia columbiana, and Wolffia paulifera.

Current Forest Management

The Town of Nags Head considers the Nags Head Woods to be an irreplaceable natural resource due to its high diversity of habitat types, diversity of species, and functions in ground water recharge and island stability. The Town's policies for protecting Nags Head Woods are to:

- protect the vegetated nature of the area by minimizing land disturbing activities.
- use an environmentally sensitive set of land use regulations which differ from standard regulations.
- prohibit logging within Town limits.
- develop privately owned areas at the lowest density possible.
- use Town owned property primarily for recreation, or if public uses such as additional Town facilities were required, they would be done in an environmentally sensitive manner (Nags Head Land Use Plan, 1985).

The Town of Nags Head has adopted zoning regulations to protect all of the town's environmentally sensitive areas within the town. All of Nags Head Woods, except for a small area of scrub forest within the Town of Kill Devil Hills, falls under Special Environmental District - 80 zoning . Under this zoning, the only uses permitted are detached family housing (minimum lot size of 80,000 square feet), small professional offices, watershed conservation areas, and non-profit wildlife and

ecological preserves. Residential cluster housing is permitted, but the density requirement is still 80,000 square feet per unit. The small portion of the Woods within Kill Devil Hills has a 5500 sq. ft. minimum lot size. Before construction can take place within areas zoned SED - 80, a site plan must be submitted and approved by the Town. This plan must show trees 16 or more inches in diameter and all trees located within 20 feet of the proposed dwelling. In addition, no trees greater than 16 inches in diameter may be removed and a permit is necessary to remove trees greater than 4 inches in diameter. Proposed structures must be located where they will disturb the least number of healthy trees and vegetation. The variety, density, and height of the vegetation within a building site is be taken into consideration before approval is granted.

Overall, the Town of Nags Head has the strictest zoning ordinances on the Outer Banks with regard to maritime forests. This is mainly due to the Town's policy of maintaining the maximum percentage of the natural vegetation. The Nags Head land use plan states that the maritime forest is a vital part of the barrier island system.

Approximately 360 acres of the Woods are owned by the North Carolina Nature Conservancy and managed as an ecological preserve. The Nature Conservancy also manages a 350-acre tract owned by the Town of Nags Head. This tract is protected as a watershed for Fresh Pond, the town's chief source of fresh water. A remaining 300-acre tract is owned by Brock Daniels of the Nags Head Woods Partnership.

Since the majority of the land is afforded protection through management by The Nature Conservancy, the major development threat to the Woods is in the area owned by the Nags Head Woods Partnership, which is soon to be subdivided. Whether or not many small disturbances from single family detached dwellings would be more damaging ecologically than fewer large disturbances from clustered housing has not been determined.

COLINGTON ISLAND

History of Forest Use

Colington Island was the first land granted in the Province of Carolina when it was given to Sir John Colleton in 1664. An attempt was made by the first settlers to establish a plantation to raise hogs, cattle, and horses (Schoenbaum 1982). Due to drought and severe weather, this plantation eventually failed. Some of the original colonists remained on the island and were able to survive by shifting from agriculture to fishing. These initial fisherman made their homes in the forest of the island. The forest was used as a source of shelter, building material, and fresh water (Schoenbaum 1982).

The island remained a small fishing village until 1750 when it came under the ownership of Thomas Pendleton. At this time, a small creek which ran halfway across the island was dug out and extended, cutting the island in two. The separate islands became known as Big Colington (Great Colenton) and Little Colington (Stick 1958).

By the early 1900s, most of the island inhabitants had moved to the north shore of Big Colington where deeper boat channels were more accessible. Hogs were noted to be free on the island in a 1937 timber survey (Settel 1937). According to Stick (1958), cattle also grazed freely on the island for several years during this time. These domestic animals were probably removed when free range grazing was banned in 1937.

Colington Island is still primarily a fishing-oriented community. Development on the island is primarily residential with several mobile home communities. Recent development now includes a private vacation home community.

Before the arrival of European colonists, Colington Island was entirely forested. Today, the island is largely developed, although fragments of the original forest are still evident along SR 1217, the single state road which runs along the northern side of the island.

FOREST SITE SUMMARY

Island: Colington
Site Name: Schoolhouse Rd
Acres: 170
County: Dare
Number: 1
USGS Quad: Kitty Hawk

Location and Directions

This forest site is located on Schoolhouse Rd. which is the first left turn off SR 1217 after the second bridge on Colington Island. This sand road runs parallel to the west shore of Colington Cut. The eastern boundary of the site is Colington Cut, which consists mostly of open salt marsh. Salt marsh is also found along the southern boundary of the tract. To the north are a series of mobile home developments which are typical of elsewhere on the island. (See Fig. 5)

Site Description

The topography of the site consists of a low dune ridge-swale system. Swales are low lying and often contain standing water. The forest canopy consists mainly of deciduous species such as: Liquidambar styraciflua, Acer rubrum and Carya glabra. Quercus falcata and Quercus laurifolia are also common species in the canopy. Pinus taeda is unevenly aged and found scattered throughout the forest. The understory and shrub layer is very dense, being comprised chiefly of Cornus florida, Ilex opaca, Persea borbonia, and Lyonia lucida. Vines are common throughout the understory and shrub layers. The most common species are Smilax species, Berchemia scandens and Vitis rotundifolia. Mitchella repens, Pteridium aquilinum and Vaccinium atroccocum are common ground cover.

Evidence of Disturbance

Schoolhouse Rd., an unimproved sand road, loops through the area along Colington Cut. There are some dump sites and trash along the road as well as a great deal of survey flagging. There are several lot clearings along another sand road which heads west off the main road. Mobile homes are found both at the beginning and the end of Schoolhouse Rd. A small cemetery sits near the southern limits of the forest site.

Ecological Significance

The site resembles a bottomland hardwood forest, with the swamp forest condition dominant throughout the tract. This area is the last major tract of forested land on Colington Island. Since most of the island consists of marshland and low lying sand ridges, this tract is probably typical of the forest which once covered the island.

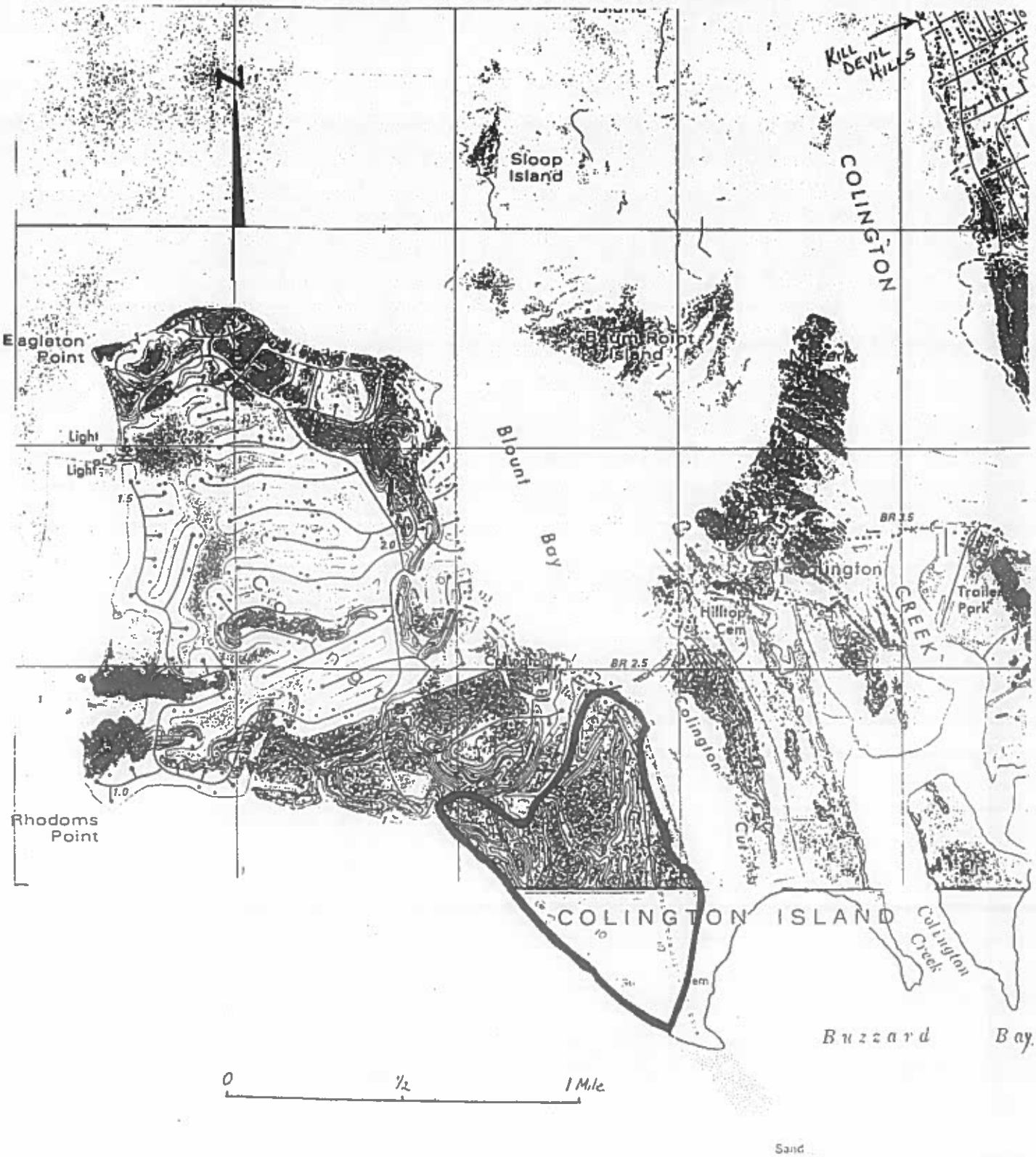
Current Forest Management:

The tract has been partially subdivided as evidenced by survey lines and lot clearings. The area was recently zoned S-1 by Dare County a generic zoning district which requires building setbacks and a 35-foot structure height limit for all the County's unicorporated areas.

There are currently no special land use policies or zoning ordinances protecting the maritime forest on Colington Island. However, the draft 1987 Dare County Land Use Plan classifies the Colington Island forest as a "limited conservation" area, within which development and land clearing activites will be managed through the creation of a special use district and permit process. Proposed guidelines for limited conservation areas include building density restrictions and limits on vegetation removal, road widths, and wetland alteration.

FIGURE 5

Colington Island: Forest Site #1 - Schoolhouse Road



ROANOKE ISLAND

History of Forest Use

Roanoke Island was the site of the first English attempts at colonization in America. The island was populated by the Roanoke Indians until the arrival of Europeans in 1584. Much of the island was originally forested. Although no formal town was established on the island, by 1669 all the land had been claimed and settled (Stick 1958). During this period the island was used for small scale farming and free range grazing. The chief livestock raised on the island were hogs and cattle (Stick 1958).

During the Civil War, a Confederate fort was built on the island which eventually fell to the Union naval forces. After the War, freed slaves erected a town of over 500 houses on the north side of the island which was eventually disbanded (Stick 1958). The Manteo post office from which the town received its name, was built in 1870. The main road across the island (US 64-264) was paved in 1924, and the Dare County Airport was built during WW II to serve as a Naval Air Station (Stick 1958).

Sections of the island were still being farmed as late as 1900 (Phil Evans-NPS, pers. comm. 1988). Many areas still exhibit signs of past disturbances with much of the forested areas in an early successional state. Presently, the towns of Manteo and Wanchese occupy much of the land. Most of the undeveloped land in the vicinity of the Fort Raleigh National Historic Site is managed by the National Park Service.

FOREST SITE SUMMARY

Island: Roanoke Island | County: Dare
Site Name: Fort Raleigh City | Number: 1A
Acres: 100 | USGS Quad: Manteo

Location and Directions

This site is located in and around the Fort Raleigh National Historic Site. The area is located along US 64-264, three miles west of Manteo Elizabeth City. The forested tract begins at the end of a service road leading from the park headquarters, and extends beyond the park boundary up to SR 1161. The northern boundary of the site is Roanoke Sound. To the east is the Fort Raleigh restored area and National Park Service facilities. The southern boundary is US 64-264, and the Sandpiper Campground lies to the west on SR 1161. (See Fig. 6)

Site Description

The topography of the site is very flat with little relief other than a gradual slope towards Roanoke Sound. Pinus taeda is the dominant species of the forest canopy, with few other species reaching canopy height. The pines are fairly dense and appear to be even-aged. The understory is shrub-like and dominated by Quercus laurifolia, Persea borbonia, and Cornus florida. Quercus falcata is also present in the understory as are scattered Quercus virginiana. The majority of the oaks in the understory are relatively small (15-20 cm dbh) and appear to be just coming up under the pines. The shrub-like oaks and other understory species are often covered with vines such as Smilax bona-nox, Rhus radicans, Vitis rotundifolia, Parthenocissus quinquefolia, Gelsemium sempervirens and Lonicera sempervirens. The ground cover consists chiefly of pine needles, with scattered patches of Mitchella repens, oak seedlings of various species, and clumps of Cypripedium acaule.

Evidence of Disturbance

There are no anthropogenic disturbances within the forest other than several intersecting paths, one or two meters wide, which loop back to the service road and a barbed wire fence that marks the park boundary and bisects the forest site. According to Phil Evans at the Fort Raleigh visitor center, the old highway across Roanoke Island ran past the site of the restored fort and service road. There were also several small farm plots along the service road during the early 1900s.

Ecological Significance

Since this area had been previously cleared for farming, the forest is currently in a successional phase with oaks replacing pines. Succession is not well understood in maritime forests and this site provides a representative example of maritime forest regeneration on Roanoke Island.

Current Forest Management

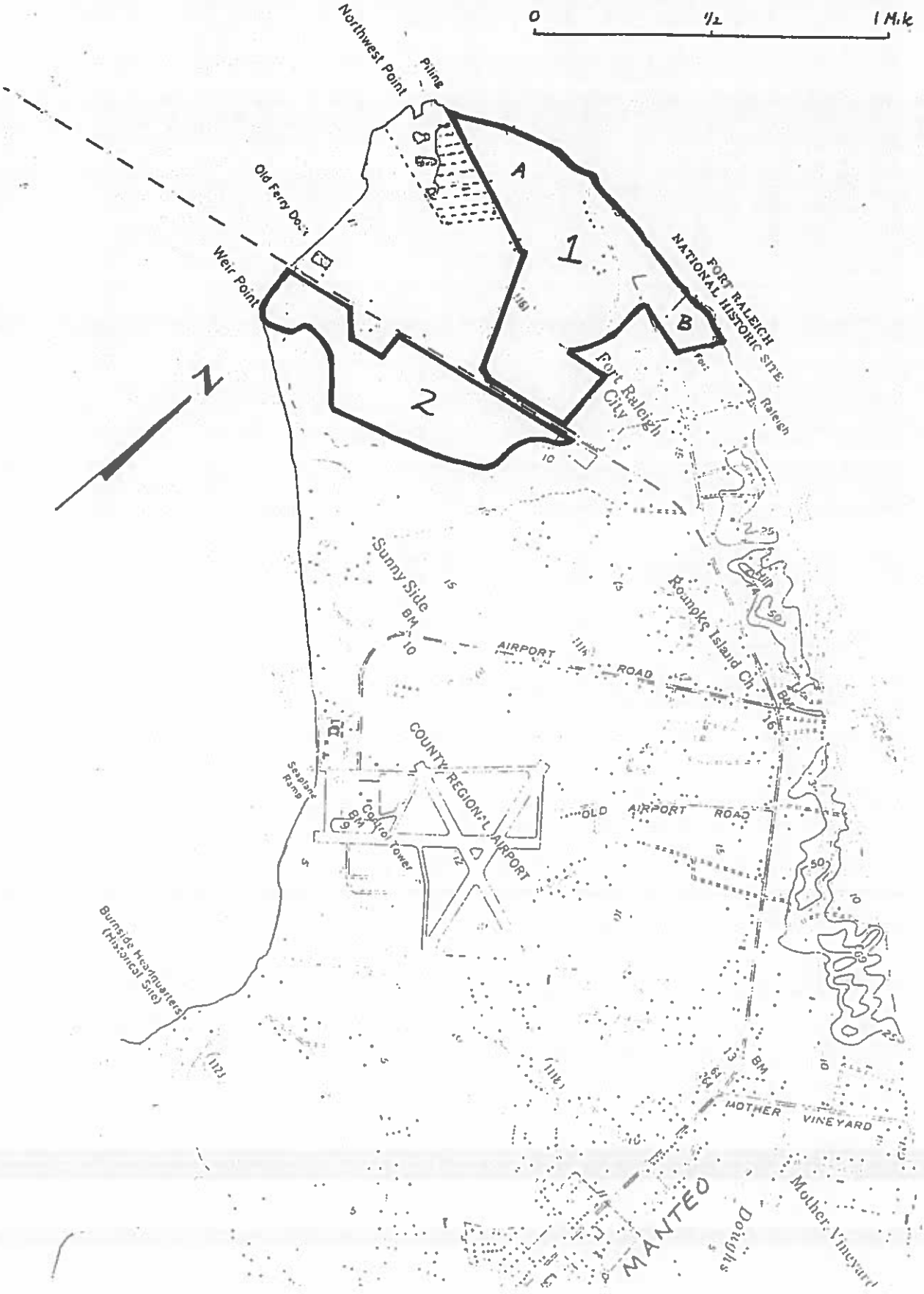
Roanoke Island has a long history of human habitation and land use. The forest areas have been heavily used for shelter,

fuel, and building materials. This has tended to perpetuate the early successional stage present in the forest today. The town of Manteo covers a large portion of the island. While most of the town is devoted to a residential type of development, a few large tracts of undeveloped maritime forest remain intact. We refer to two of these tracts as the Weir Point Site and the Fort Raleigh City Site (see Fig. 6).

The Fort Raleigh City site is currently zoned as a Natural Historic district (NH). According to Dare County's zoning ordinance, the NH district is intended to protect the natural beauty of the area. Permitted uses are single-family housing, wildlife refuges, historic sites, and state and national parks. The minimum lot size for single family housing is 15,000 square feet. However, as in the R-1 district, there are no provisions regulating the removal of vegetation except for a buffer strip requirement between property lines and Highway 64-264. Some of the present owners of the Fort Raleigh City site requested a zoning change from the Natural Historic district to a commercial district in order to have a shopping center built. The majority of the site is within the park boundary. Presently, there are no plans for expansion of park facilities into this area.

FIGURE 6

Roanoke Island: Forest Sites #1a and #1b - Fort Raleigh City A & B
Forest Site #2 - Weir Point



FOREST SITE SUMMARY

Island: Roanoke Island
Site Name: Fort Raleigh City
Acres: 5

County: Dare
Number: 1B
USGS Quad: Manteo

Location and Directions

Fort Raleigh National Historic Site. Located on US 64-264, three miles west of Manteo. The forest area is in the vicinity of the park nature trail, west of the restored fort. The northern boundary of the forest is Roanoke Sound. The eastern and southern boundaries are the Fort Raleigh restored site and facilities. The Elizabethan Gardens are the western boundary. (See Fig. 6)

Site Description

This forest site includes the area of the nature trail (1/4 mile loop) and the area north of the Elizabethan Gardens. The topography of this site appears to be a series of disjointed and curved dune ridges. The ridges are not very high (1-2 meters), and are close together resulting in not very broad swales (5-10 meters).

Although the most abundant species in the forest canopy is Pinus taeda, the trees do not seem to be even-aged as in other sections of the park. Some individuals are large with a 50-60cm dbh. Other species common to the canopy are Quercus virginiana, Quercus laurifolia, and Carya glabra. The understory is well developed, with mature individuals of Ilex opaca, Persea borbonia, and Cornus florida. Scattered throughout the understory are small hickories (Carya glabra), as well as individuals of Morus rubra and Diospyros virginiana. The northern sound side edge of the forest is dominated by a Quercus virginiana shear forest fringe approximately 20 meters wide. The ground cover is comprised chiefly of leaf litter, Smilax species, Parthenocissus quinquefolia, and a large amount of Mitchella repens.

Evidence of Disturbance

The only evidence of disturbance in the area is the park nature trail which loops out to the sound side shear forest and back to the restored fort (1/4 mile).

Ecological Significance

Due to the abundance of large oaks and other canopy species, this forest site would seem to have had less human disturbance than other areas within the Fort Raleigh/Park Service boundaries. This site appears to be more representative of the mature maritime forest habitat on Roanoke Island.

Current Forest Management

The entire forest area occurs within the Park Service boundaries. The Park Service currently has no plans for expansion of facilities into other areas of the park.

FOREST SITE SUMMARY

Island: Roanoke Island
Site Name: Weir Point
Acres: 86

County: Dare
Number: 2
USGS Quad: Manteo

Location and Directions

The forest area can be found at the northwestern tip of Roanoke Island, approximately four miles west of Manteo, along the south side of US 64-264. The site is immediately behind a highway rest area located near the bridge over Croatan Sound. The forest is bounded on the north by the rest area. To the south and east is salt marsh that is designated as the NC State Fessenden Memorial. This memorial is comprised of a series of tidal creeks and approximately 30 acres of marsh land. The western boundaries are delineated by fresh and salt water marshes. (See Fig. 6)

Site Description

The topography of the area is flat with wet depressions that grade into fresh water marsh. Pinus taeda dominates the forest canopy along with the oaks Quercus falcata, and Quercus rubra. Common to the swamp forest canopy are Liquidambar styraciflua, Nyssa sylvatica, and Acer rubrum. The understory is a dense tangle of vines (Smilax species, Vitis rotundifolia, and Gelsemium sempervirens), with Carpinus caroliniana, Cornus florida, Ilex opaca, and Persea borbonia being the most common tree species. A distinct shrub layer of Vaccinium atroccocum exists in the drier areas. Also present in the shrub layer are Myrica species, Lyonia lucida and scattered Quercus virginiana.

The ground cover is also dense with Arundinaria gigantea, Pteridium aquilinum and the various vine species. Also common on the forest floor are patches of Cypripedium acuale. The western edge of the forest closest to the sound is dominated by a Quercus virginiana fringe. The fringe is approximately 10-20 meters wide, and separates the fresh water marshes from the sound.

Evidence of Disturbance

There is no evidence of any recent disturbances within the forest interior.

Ecological Significance

This site provides an example of the mixed pine and hardwood forests which once existed over much of Roanoke Island. Important habitat types represented here include: swamp forest, fresh and salt water marshes transitions, and a live oak shear forest.

Current Forest Management

There are several residential zoning districts in Manteo of which the R-1 is the most environmentally sensitive, encouraging only low density, residential development. The Weir Point site is zoned R-1 with a minimum lot size of 15,000 square feet. While this zoning may help protect fragile natural areas from

more intense land uses, there are no restrictions on vegetation clearing within the R-1 district. Although buildings may not occupy more than 30% of the total lot area, the entire lot may be cleared. To protect the ecological integrity of the forested areas, limitations on vegetation clearing would need to be incorporated into the zoning ordinances.

There are no immediate development threats to the forest, although subdivisions are possible with a current zoning of R-1. This zoning would allow single family residential housing with a minimum lot size of 15,000 square feet. Development would be difficult in this tract due to the extensive wetlands.

HATTERAS ISLAND

History of Forest Use

The Buxton Woods is one of the few areas on the Outer Banks that was inhabited by Native Americans. This is attributed partly to the fact that this portion of Hatteras Island is one of the widest parts of the Outer Banks. Archaeologists believe that these woods may have been the site of Croatoan, the capital of the Algonquian Indians. Early European settlers also made their homes within the well developed forest situated on the high dune ridges west of Cape Hatteras. This area, originally called The Cape, became known as Buxton in 1882 (Stick 1958).

As with many of the other islands of the Outer Banks, the primary occupation of the local inhabitants was fishing and the raising of livestock. According to interviews conducted by Bratton and Davison (1987), prior to the banning of free range grazing in 1937, cattle and horse populations in the Buxton Woods area were considered to be in the hundreds. Sheep and goats were also common in the Woods.

Buxton Woods has been logged at various times in history. The earliest logging activities were probably the selective cutting of live oak and red cedar, which were used in ship building (Stick 1958). In a timber survey conducted by Settel (1937), a reference is made to the harvesting of loblolly pine eight inches in diameter from Buxton Woods around 1900. According to Bratton and Davison (1987), many property owners sold timber rights to various logging companies at the turn of the century. The logging agreements were usually for pines, oaks, dogwoods, and holly greater than eight inches in diameter. Local people also harvested dogwood from the Woods to be sold as spindles for use in cotton mills. Firewood was also cut by the local population, both for home and sale until the early 1940s (Bratton and Davison 1987).

Prior to 1950, fire was considered a common occurrence within Buxton Woods. These fires were usually set intentionally for brush removal, pond clearing for ducks, and hunting. Fires in recent years have usually been smaller, less numerous, and more controlled than in the past. The most probable causes have been smoking, fireworks, and campfires (Bratton and Davison 1985).

Buxton Woods includes approximately 3,000 acres of dense maritime forest and relict dune-swale system, of which 920 acres are managed as part of Cape Hatteras National Seashore. Another 330 acres are managed by the state as part of the North Carolina Coastal Reserve. The remaining 1,750 acres are subdivided into hundreds of privately owned parcels ranging from small sized lots to tracts of over 100 acres.

One large area (170 acres) comprises the extensive public well field of the Cape Hatteras Water Association (CHWA). The

well field is a state designated public water Area of Environmental Concern (AEC), with 35 shallow wells (expansion underway) providing fresh water to Hatteras, Frisco, Buxton, and Avon. The quantity and quality of water under Buxton Woods makes it the major source of fresh water on Hatteras Island.

Most of the Woods located north of NC Highway 12 have been developed, with small established communities dotting the estuarine shoreline and commercial areas providing services along both sides of the highway. The areas to the south of Highway 12 are far less developed with a few house tucked inside the dense forest. Interior sections of the Woods have recently come under increased pressure from development. Several unimproved sand roads provide access to the Woods for hunting, picnicking, and hiking on trails atop dune ridges. Roadside dumps and sand mines are also found in parts of the forest.

FOREST SITE SUMMARY

Island: Currituck Banks
Site Name: Buxton Woods
Acreage: 3000

County: Dare
Site Number: 1
USGS Quad: Hatteras/
Cape Hatteras/Buxton

Location and Directions

The site is located on Hatteras Island, 45 miles south of Manteo. The southern boundary of Buxton Woods is within the Cape Hatteras National Seashore. Approximately 900 acres are within the Park Service boundaries. The towns of Buxton and Frisco are along the northern and western boundaries. Highway 12 also runs along the western edge of the forest. (See Fig. 7)

Site Description: The seaward leading edge of the forest near the active beach is a Quercus viginiana and Juniperus virginiana dominated shrub thicket. Also prevalent in the shrub thicket are Myrica cerifera and Pinus taeda. This vegetation type is commonly found in the swales where the dunes offer some protection from wind and salt spray. Many of these swales have standing water at times and support aquatic vegetation.

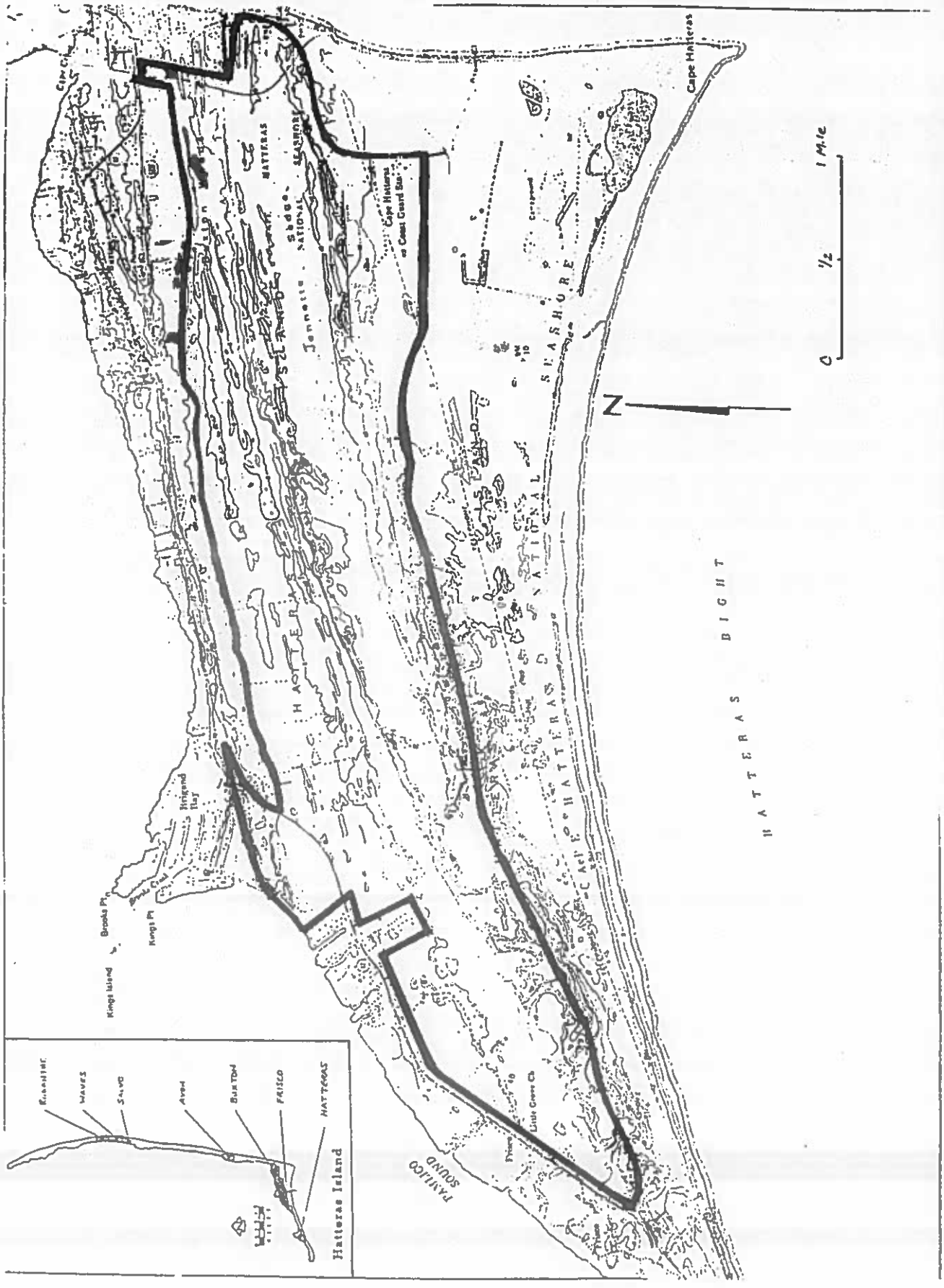
As the distance from the active beach increases, the elevations and age of the successive dune ridges also increase. Where the elevations are greater, the morphology of the shrub thickets become more forest like in appearance, with canopy heights of 5-7 meters. These patches of forest are also found only within the sheltered areas of the swales. Species common to these patches of forest are Quercus virginiana, Juniperus viginiana, and Pinus taeda, with Persea borbonia beginning to become more abundant in the developing understory. The ground cover of these forest patches consists primarily of leaf litter with occasional Sabal minor.

Once the oldest dune ridges are reached, the forest becomes contiguous, both on the ridges and in the swales. The most abundant species in this part of the forest are Quercus virginiana, Juniperus virginiana, and Pinus taeda. The interior forest canopy is comprised of Quercus laurifolia and Pinus taeda. Abundant understory species include Carpinus caroliniana, Cornus florida, Ilex opaca, Persea borbonia and Osmanthus americana. Juniperus virginiana is occasionally found as an understory species. The common shrub layer species are Ilex vomitoria and Myrica cerifera which often reach the subcanopy in more disturbed areas of the forest

The topography of the interior forest is a series of dune ridges which can reach a height of 20 meters. Between these ridges are broad swales, many of which contain standing water year round. These fresh water marshes are called sedges by the local residents, the largest of which is Jennette Sedge (400 acres). Several smaller sedges exist to the north and west. Most of these wetland areas are covered by Typha latifolia and Cladium jamaicense, but some of the larger areas have open water.

FIGURE 7

Hatteras Island: Forest Site #1 - Buxton Woods



Associated with the sedges are areas of swamp forest. Cornus stricta and Persea borbonia are the most abundant woody species in these areas. Common canopy species in and around the swamp forest are Acer rubrum and Ligidambar styraciflua. These species are found scattered throughout the swamp forest but do not form a closed canopy.

Evidence of Disturbance

According to Bratton and Davidson, (1987), the major disturbances within Buxton Woods have been logging, grazing, and fire. Domestic animals were removed from the area when free range grazing was prohibited in 1937. The Woods was also logged heavily for hardwoods during the late 1800s during which the selective cutting of trees greater than eight inches in diameter was common. This resulted in a pine (Pinus taeda) dominated forest with isolated stands of old trees scattered throughout. The most recent episode of logging took place in the early 1970s with the clear cutting of a 100-acre lot in the middle of the Woods. A dense growth of young pines now dominates this area.

The major disturbances within Buxton Woods today are residential development and sand mining. Several sand roads run through the Woods along major dune ridges. There are several crude shelters which can be found in small clearings along these roads with some large dump sites located in southern sections of the forest.

Ecological Significance

Buxton Woods is the largest tract of maritime forest remaining on the North Carolina coast. The site contains representative examples of all the typical maritime forest habitat types and associated species, ranging from successional forest patches and mature forested ridges, to interdunal ponds and swamp forest. The swamp forests and fresh water marshes are unique variants of their community types, occurring nowhere else in the state (Weakley and Schafale 1987).

The diversity of habitats allow the Woods to support a variety of rare flora and fauna (Quay 1959). Eight rare plant species monitored by the North Carolina Heritage Program have been reported from the area, the greatest concentration of rare plant species on the Outer Banks (Weakley and Schafale 1987). Webster (1988) states that mammalian diversity in Buxton Woods is greater than on any other forested barrier island in North Carolina or adjacent states.

The extent and diversity of habitat types within Buxton Woods make it an ideal site for ecological and geological studies of maritime forests. Buxton Woods is also the area of primary groundwater recharge for the large aquifer providing fresh water to the villages of Hatteras, Frisco, Buxton and Avon.

Current Forest Management

The management of Buxton Woods has received considerable attention in recent years. In an effort to defeat a proposal to

build a golf course in the forest, an area of approximately 3,000 acres was nominated for state designation as an Area of Environmental Concern (AEC). At the time of this proposal, there had been no local zoning at the Buxton Woods site.

To eliminate the need for an AEC designation by the NC Coastal Resources Commission, Dare County adopted the Buxton Woods Special Environmental District - 1 (SED-1). According to the SED-1 ordinance, the purpose of this zoning is:

> "...to protect public health and welfare, to preserve the quality of the fresh water supply aquifer which lies beneath Buxton Woods Forest, to provide environmentally compatible setting for low density residential housing, and preserve the economic, aesthetic, and unique and irreplaceable natural resource assets of the land, vegetation, surface waters, and underground waters of the district."

Under SED-1 zoning, the minimum lot size for a single-family residential dwelling is 40,000 square feet. Cluster housing is also permitted at a density of one dwelling unit per 40,000 square feet, provided that the total property area is at least 160,000 square feet and that the cleared area will not exceed 20% of the total property. Next to the Nags Head Woods (SED-80), this is probably the strongest local resource protection ordinance in the state.

The most immediate threat to the ecological integrity of Buxton Woods is the residential development now taking place within the forest. Increased development and the resulting forest fragmentation will likely lead to a decrease in habitat and species diversity within Buxton Woods.

SHACKLEFORD BANKS

History of Forest Use

Shackleford Banks is an east-west oriented barrier island located just west of Cape Lookout. The island stretches for 15 kilometers from Bardens Inlet westward to Beaufort Inlet, and has a maximum width of approximately 1.0 kilometer. According to Fisher (1967), the island originated as a distal prograding spit of Cape Lookout about 2000 years ago.

Prior to the appearance of European settlers, Shackleford Banks, like many of the other Carteret County barrier islands, was used for hunting and fishing by local Native Americans but not inhabited by them. Shackleford was almost entirely forested at this time. The island was acquired by John Shackleford in 1723, and the first permanent dwelling was built at the eastern end in the early 1760's (Stick 1958). This section of the island was soon occupied by more than 500 people and became known as Diamond City by 1885. Around this time there was also another smaller community at the western end, known as Wades Hammock.

The inhabitants of Diamond City made their living by fishing, whaling, and logging. During the 1800s, live oak was much in demand for ship timbers and most of the North Carolina coast was logged extensively. Shackleford Banks was a good source of live oak and red cedar, which resulted in large portions of the forest being timbered (Stick 1958). Livestock was also raised on the island and allowed to graze freely in the forest.

In August of 1899, Shackleford was struck by a severe hurricane which washed over much of the island. Many homes, gardens, and livestock were lost. After the storm, the majority of residents felt that the island was no longer a safe place to live, and within three years all had moved to nearby Harkers Island and Bogue Banks (Stick 1958). The island was still used as a place for whaling and fishing for several more years until 1909 when these activities were abandoned at the Diamond City site (Stick 1958). All that remains of Diamond City and Wades Hammock today are several graveyards and the descendants of the abandoned livestock (Schoenbaum 1982).

As mentioned above, maritime forest once covered most of Shackleford Banks (Au 1969). High winds and salt water inundation associated with the storm of 1899 destroyed a large portion of this forest. Sand destabilization following the destruction of the vegetation resulted in the burial of additional forested areas (Au 1969). The livestock abandoned by the residents of Diamond City formed feral populations which severely grazed the remnant forest area, furthering the destabilization process.

In 1986, the National Park Service acquired Shackleford Banks as part of the Cape Lookout National Seashore. According

to the Cape Lookout Management Plan, the seashore will be maintained as a wilderness area. The Park Service removed all the fishing camps which had been built in recent years as well as most of the cattle, sheep, and goats. The horses, however, were allowed to remain on the island due to their aesthetic appeal to local area residents, and for the tourists wishing to see the "wild ponies of Shackleford Banks". As a result, the forest is still intensely grazed. There is little understory vegetation; the edges of the forest are open to the effects of salt spray and wind driven sand. Hundreds of feral animal paths wind their way throughout the forest. No formal studies, however, have been conducted to ascertain the effects of the horses on the forest vegetation.

Although the island itself is protected from development, the fate of this diminished maritime forest remains in question.

FOREST SITE SUMMARY

Island: Shackleford Banks
Site Name: Shackleford
Acreage: 90

County: Carteret
Number: 1
USGS Quad: Beaufort/ Harkers Island

Location and Directions

Shackleford Banks is part of the Cape Lookout National Seashore, located 3.2 kilometers south of Beaufort. The forest is found on the sound side at the western portion of the island, and is accessible only by boat. (See Fig. 8)

Site Description

The topography of the site is comprised of hummocky dunes which form a dune ridge system with a northwest-southeast orientation. The soils of the area are mapped as Newhan-Corolla Complex, Duckston Fine Sand, Corolla-Duckston Complex, and Lafitte Muck series.

The forest is very open due to the extensive grazing by feral ungulates. There is an obvious browse line where the forest has been eaten away, creating a substantial edge effect (increased light and salt spray penetration). The canopy is dominated by Quercus virginiana and Juniperus virginiana. Understory tree species are scarce to absent. Isolated individuals of Ilex opaca, Carpinus caroliniana, Cornus florida, and Persea borbonia are present with Ilex opaca being the most common.

There is little seedling recruitment of tree species other than root suckering of Quercus virginiana. Vines are very abundant but heavily grazed throughout the forest, with the most common being Rhus radicans, Smilax bona-nox, Vitis aestivalis, and Parthenocissus quinquefolia. Ground cover is sparse where it exists, and includes: Mitchella repens, Sabal minor, Panicum species, Asplenium platyneuron, and Elephantopus nudatus. Freshwater marshes containing abundant and varied aquatics are located throughout the forest.

Evidence of Disturbance

The island has a long history of human disturbance which includes a town of more than 500 people (Diamond City) during the early 1800s, logging, and the grazing of livestock. Today, feral ungulates still graze the island's marshes, dunes, and forest even though the National Park Service intends to remove the cattle, sheep, and goats. There are numerous animal paths throughout the forest.

Other recent disturbances have centered around fishing camps located on the sound-side of the island. These camps consisted of crude structures built by the locals of the nearby mainland. Most of these structures have been removed by the National Park Service. The sound side of the island is also used heavily as a picnic and camping area. Because of this use, there

has been heavy trampling and cutting of the forest vegetation near the sound and a large amount of trash has accumulated.

Ecological Significance

Shackleford Banks is one of the few barrier islands in North Carolina that is uninhabited. Since its incorporation into the National Seashore system, the entire island has been protected from development. The natural state of the island offers itself as a unique outdoor laboratory in which researchers are able to study the ecology and environmental processes of barrier islands.

Current Forest Management

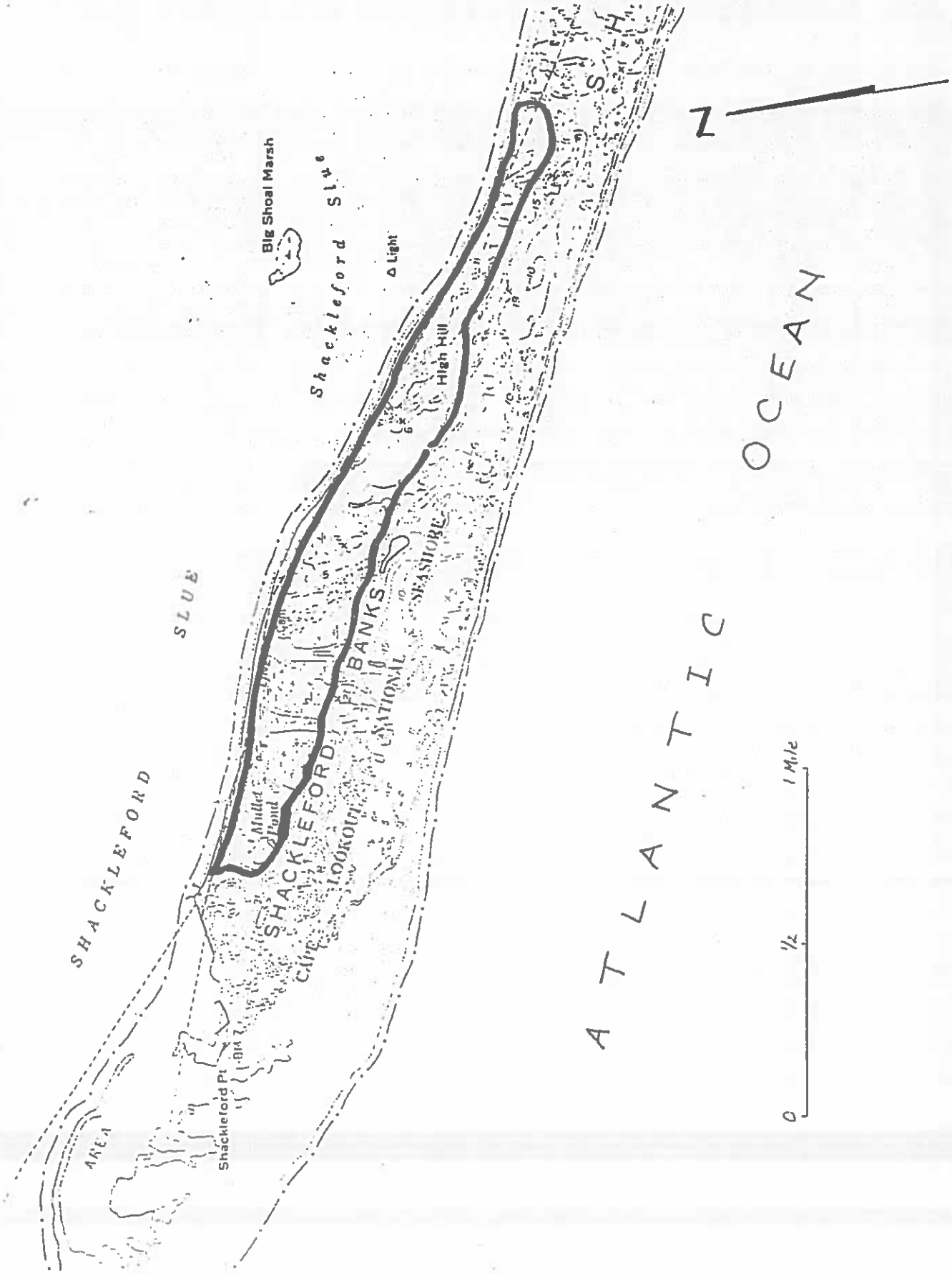
Shackleford Banks is a component of the Cape Lookout National Seashore. Although included in the National Seashore Management Plan, no management policies have been written specifically for the island. Shackleford is currently being managed as a wilderness area, with uses limited to fishing, hiking, and primitive camping. The use of off-road vehicles is prohibited on the island.

Upon incorporation of Shackleford Banks into the National Seashore, the majority of the feral livestock was removed. Approximately 100 sheep and a small herd of cattle remain on the island. Horses were allowed to remain due to their aesthetic value to visitors. According to recent studies and observations (Evans and Lopazanski 1988), the feral ungulates are having a negative impact on tree seedling recruitment and on the general processes of maritime forest succession.

If the island is to be managed as a wilderness area, and the ecological integrity of the maritime forest is to be preserved then it will be necessary to remove all of the feral animals as soon as possible, or manage them in a way such that their populations are strictly regulated. Efforts are currently being made by the National Park Service to remove more of the sheep and cattle but a horse management plan has yet to be formulated.

FIGURE 8

Shackleford Banks: Forest Site #1 - West End of Shackleford



BOGUE BANKS

History of Forest Use

Bogue Banks, one of the largest islands on the North Carolina coast, stretches for 25 miles between Beaufort Inlet and Bogue Inlet. The island was formed about 10,000 years ago from a dune ridge along the ancestral Carolina shore that became isolated from the mainland during a rise in sea level (Pilkey et al. 1980). Since its formation, Bogue Banks has been migrating across the continental shelf with the retreat of the mainland shoreline. Within the last 5000 years, sea level rise has slowed as has the migration of the island. The processes of island overwash, inlet formation, inlet migration, and the action of winds, have all contributed to the elevation and widening of the island which in turn has promoted the development of maritime forests. The oldest existing forested dune ridge on the island is approximately 1400 years old (Fisher 1967).

Before colonization of North Carolina by European settlers in the 1500s, Bogue Banks was visited by Native Americans who used the island for hunting and fishing, but made no permanent settlements there. The island's first white inhabitants were from Diamond City on nearby Shackleford Banks, who after the devastating hurricane of 1899, began moving to the area now known as Salter Path (Henderson 1983). At that time the island was almost completely covered by a dense maritime forest, an excellent place for the people to live because of the protection it afforded. The main occupation of these people was fishing, raising livestock, and ship building.

Prior to the 1920s, the island was only sparsely inhabited, with the first bridge built in 1928 (Pilkey et al. 1980). The island remained relatively undeveloped until the 1950s when several hotels and beach cottages were built on Atlantic Beach. At that time, the land from Atlantic Beach to Salter Path was owned by Alice Hoffman. The land west of Salter Path was owned by Philadelphia businessman, Henry Fort (Schoenbaum 1982). In 1918, Alice Hoffman tried to have the inhabitants of Salter Path removed from her land, but a court settlement determined that the people had squatter's rights under the "legal doctrine of adverse possession", and so they remained (Schoenbaum 1982).

The commercial development of Bogue Banks began on the eastern end at Atlantic Beach. This area was cleared for motels, condominiums, night clubs, etc., and is now devoid of any maritime forest. Development continued to spread westward with the incorporation of Pine Knoll Shores in 1973. Pine Knoll Shores is located on some the highest, most stable, and subsequently, one of the most heavily forested parts of the island (Pilkey et al. 1980). It is here that the largest remaining tract of Bogue Banks maritime forest can be found. This tract, the Theodore Roosevelt Natural Area, consists of 290 acres of relatively undisturbed maritime forest and associated

marshes. Nearly all the land on the south side of NC Highway 58 is now occupied by motels and condominiums.

Within the past ten years the Emerald Isle section of Bogue Banks has been subjected to extreme development pressures. Within the past two years alone, a portion of Coast Guard Road has been re-directed and four major development projects have been built in what was previously a contiguous tract of undisturbed maritime forest.

In recent years, alternative development practices have been pursued on Bogue Banks which have attempted to be more environmentally sensitive. Pine Knoll Shores has examples of both the old and new development practices. The older sections of the town are set up in a grid pattern which disregards the natural contours of former dune ridges. More recently developed areas retain a more contiguous canopy and the roads that curve with the land. The Beacon's Reach development is the best example of this new development philosophy. Condominiums and single-family homes sites have been built with minimal vegetation removal. However, the average projected density of homes at Beacon's Reach is high at four units per acre. Although homes are now widely spaced throughout this development, increased density will undoubtably involve further clearing of the natural vegetation.

FOREST SITE SUMMARY

Island: Bogue Banks
Site Name: Hoop Pole Creek
Acres: 12
County: Carteret
Number: 1
USGS Quad: Mansfield

Location and Directions

From Atlantic Beach head west on NC 58 to 0.6 miles west of the corporate boundary; the site is located on the north side of the highway, across from the Peppertree Resort and Food Lion. Access is via a sand road at the historical marker, marking the landing site of Union Troops during the siege of Fort Macon. This privately owned forest tract is bounded on its northern side by marsh fringes. Its southern boundary is NC 58. There is a recent clearing and building site to the east and its western boundary is along the Atlantic Station shopping mall. (See Fig. 9)

Site Description: The topography of the site is generally one of dune ridges with dry swales. The ridges extend out into the sound, creating a forested peninsula. This forested peninsula, surrounded by marsh, is similar to what is found in the Theodore Roosevelt Natural Area. The soils are mapped as Duckston Fine Sand and Newhan-Corolla series.

The most significant features are a distinct dune ridge system and a mature live oak stand extending out into the marsh. The most abundant tree species in the forest is Quercus virginiana. Also found in the canopy are scattered Juniperus virginiana and Pinus taeda. Dominant in the understory are Persea borbonia and the shrub Myrica cerifera. Myrica cerifera was most prevalent in the swales between the dune ridges. Also in the swales were stands of Quercus laurifolia. There was no swamp forest in the area. Although there was much Juniperus virginiana in the understory, large trees were noticeably absent. There was also very little Quercus virginiana recruitment. In all, the forest canopy was fairly open and salt spray may be a significant limiting factor determing canopy composition. The low density and sparse understory of this forest is similar to the forest on Shackleford Banks. Understory and ground cover is composed primarily of seedings/saplings of Persea borbonia, Quercus laurifolia, Ilex vomitoria, and Myrica cerifera. Also within the ground cover are: Asplenium platyneuron, Galium species, Rhus radicans, Smilax bona-nox, and Vitis aestivalis.

Evidence of Disturbance

The most obvious disturbance in the area is a paved road approximately 10m wide which winds through the tract from NC 58 to the saltmarsh. There are cutting and dumping disturbances along the road and in the marsh. Surveying flags and property line clearings were noted through out the tract. Although there is much Juniperus virginiana in the understory, it is lacking in the canopy. The lack of mature red cedars, in addition to evidence of recent cuttings, may indicate selective logging on the site. The forest appears to be mature but selective type cutting disturbances have caused canopy openings and the

appearance of early successional species. Since this is a small tract the "edge effect" phenomenon is especially evident.

Ecological Significance

Although small in size, this site is important because it is the last of the extensive maritime forest that once covered the Atlantic Beach section of Bogue Banks. The site also contains old growth live oak.

Current Forest Management

The Atlantic Beach land use plan recognizes the maritime forest as an important natural resource, helping to maintain the stability of the island, improve water quality, and add to the beauty of both the town and the island. The Town's policy on development within the maritime forest is "...to protect as much of this resource as possible while allowing for a moderate amount of development which would not be destructive to the uniqueness of this resource" (Atlantic Beach 1988 LUP Update). The land use plan further states that it is desirable to shift development pressures away from the forest and into the existing open areas, and if development is to occur within the forests, large lot sizes will be required to protect this important resource.

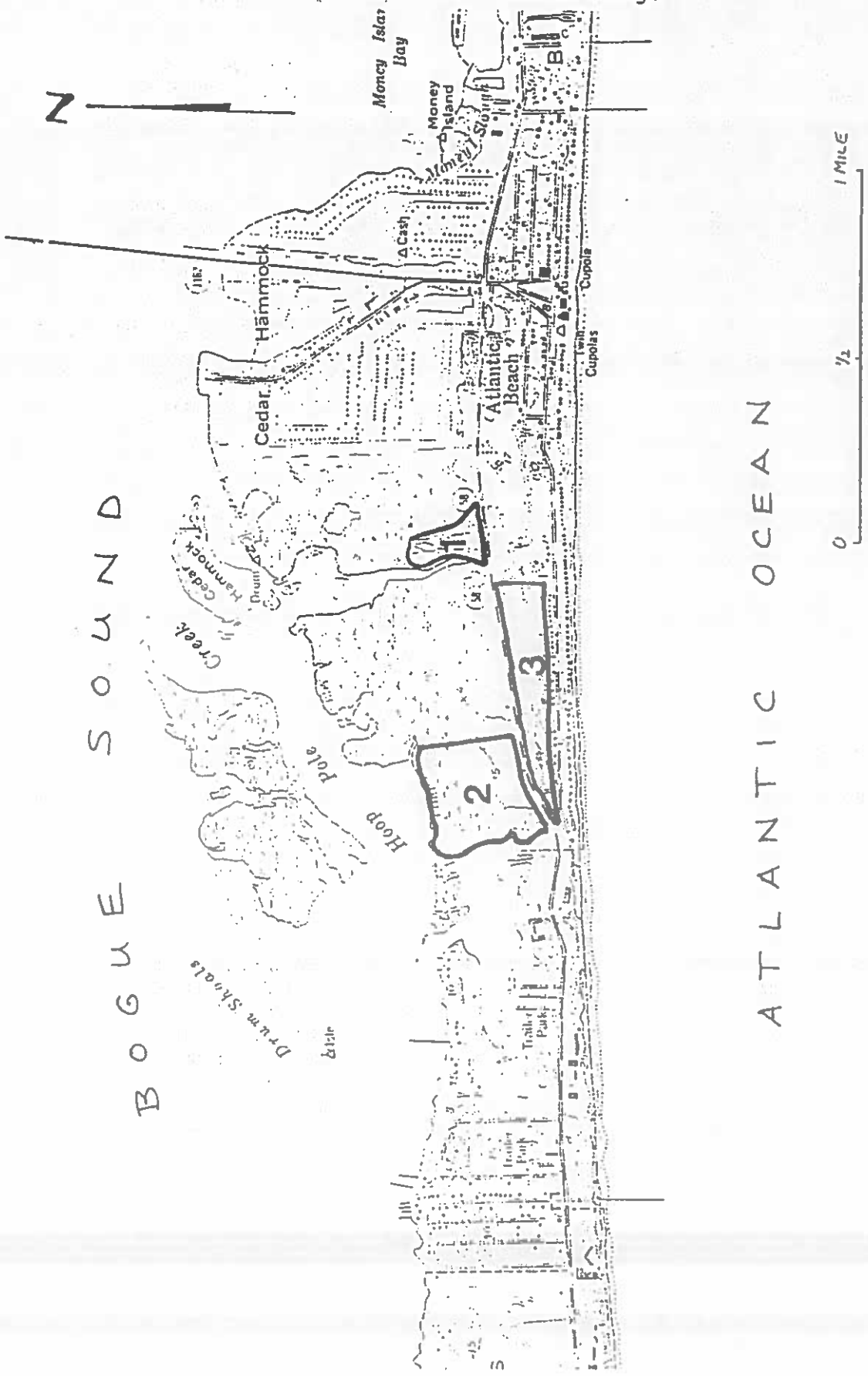
The Atlantic Beach area has the least amount of maritime forest remaining (57 acres) of all the sites surveyed on Bogue Banks. Despite the value placed on the forest by the Town, the land use plan states:

> "Further, it is the Town's policy that the overall benefits resulting from public improvement projects of town-wide significance may outweigh the desire to preserve as much maritime forest as possible. For example, the clearing of maritime forest to construct a waste water treatment plant designed to serve the entire town would be justified because of overriding benefits that would acrue to the public at large."

There are three significant forest sites located within Atlantic Beach. All three - Hoop Pole Creek, Atlantic Station, and Ocean Ridge - fall under the Town's Resort/Residential zoning ordinance, with the minimum lot size for a single family dwelling being 7000 sq. ft. This zoning is based on aspects of a site (i.e., location, natural features, access) which have a high potential for permanent and tourist types of residential use. Single family dwellings, multi-family dwellings, hotels, condominiums, tennis courts, and golf courses are all permitted. This type of zoning, with its diversity of allowable uses, seems to be inconsistent with the aforementioned policies for development within maritime forests. The sewage treatment facility referred to in the land use plan, has been proposed for construction on the Atlantic Station site.

FIGURE 9

Bogue Banks: Forest Site #1 - Hoop Hole Creek
Forest Site #2 - Atlantic Station
Forest Site #3 - Ocean Ridge



FOREST SITE SUMMARY

Island: Bogue Banks
Site Name: Atlantic Station
Acres: 45
County: Carteret
Number: 2
USGS Quad: Mansfield

Location and Directions: The site is located adjacent to the Atlantic Station shopping mall on NC 58. The site is bordered by marsh and Hoop Pole Creek on the northern side and Hoop Pole Creek to the west. The eastern boundary is the Atlantic Station parking lot and NC 58 is to the south. (See Fig. 9)

Site Description: The topography of the site is generally flat with a very gradual grade into the marsh on the sound side. There are some small dune hummocks through out the area. The soils are mapped as Duckston Fine Sand series. The most characteristic features of this site are its flatness and homogeneity. Vines (Rhus radicans, Smilax bona-nox, and Vitis aestivalis) are common both on the ground and in the canopy. The most abundant tree species is Juniperus virginiana but Quercus virginiana is also present in the canopy. No Quercus laurifolia was observed. The most abundant species throughout the site is Rhus radicans. It dominates the ground cover and is equally abundant in the canopy. Most abundant in the understory is the shrub Ilex vomitoria which is also abundant in the canopy, as well as Persea borbonia, Osmanthus americana, and Myrica cerifera. The ground cover is chiefly comprised of seedlings of Persea borbonia, Osmanthus americana, Ilex vomitoria, Myrica cerifera, and Quercus laurifolia.

Evidence of Disturbance:

Although there are no obvious current human disturbances, the area lacks a developed understory tree layer. The typical maritime forest understory tree species are present, but only in sapling form. Overall, the site seems in the early stages of succession.

Ecological Significance:

This is an excellent example of a forest that has developed on the flat tidal deposits of an old inlet. According to Fischer (1967) an inlet spanned this portion of Bogue Banks about 130 years ago. This site is of ecological interest because it provides clues to the understanding of maritime forest development as a result of primary succession.

Current Forest Management:

All three Atlantic Beach Sites - Hoop Pole Creek, Atlantic Station, and Ocean Ridge - fall under the Town's Resort/Residential zoning ordinance. This zoning (as discussed for Hoop Pole Creek) is based on aspects of a site (i.e., location, natural features, access) which have a high potential for permanent and tourist types of residential use. Single family dwellings, multi-family dwellings, hotels, condominiums, tennis courts, and golf courses are all permitted. The Town of Atlantic Beach plans to build a waste treatment facility and a post office on the site.

FOREST SITE SUMMARY

Island: Bogue Banks
Site Name: Ocean Ridge
Acres: 15

County: Carteret
Number: 3
USGS Quad: Mansfield

Location and Directions

The site is located directly across from the Atlantic Station shopping center on NC 58 in Atlantic Beach. This tract is a very narrow strip of forest (less than 200m wide) bounded by dunes with development on one side and a heavily travelled highway on the other. The site is bounded to the north by NC 58, a Food Lion shopping center to the east, and the intersection of Ocean Ridge Dr. and NC 58 to the west. The forest's southern boundary is delineated by the dune system and Ocean Ridge Dr. (See Fig. 9)

Site Description

This forest site consists of a narrow strip of live oak forest located immediately behind the active dunes along Ocean Ridge Dr. The site is slightly inclined towards the open dunes, with small hummocky dunes present within the forest. The soils of the area are mapped as Duckston Fine Sand series.

The most significant feature of this area is that the leading edge of the forest is less than 500m from the active beach. There is also a 10m high dune which is migrating into the forest. The most abundant tree species is Quercus virginiana. The canopy is closed, low, and heavily influenced by salt spray and wind shear. The understory species are sparse, comprised mostly of Ilex vomitoria, Myrica cerifera, and Persea borbonia. The ground cover consists predominantly of root suckers and seedlings of Quercus virginiana with Rhus radicans and Smilax bona-nox also common.

Evidence of Disturbance

The site is a mature live oak shear forest that is heavily influenced by salt spray. There are no man made disturbances in the forest interior, but there are dunes migrating into the forest. Approximately two acres have been cleared for the building site of the Bogue Banks Baptist Church on the side adjacent to NC 58.

Ecological Significance

This stand, although small, provides an example of an undisturbed dune/forest ecotone. The live oak trees are stunted and manifest a sheared canopy morphology. There is very little of this shear forest ecotone left on Bogue Banks.

Current Forest Management

This site, like the previous two, falls under the Town of Atlantic Beach's Resort/Residential zoning ordinance which affords no significant protection from development. Given the current rate of development around it, this forest tract may not have much of a future.

FOREST SITE SUMMARY

Island: Bogue Banks County: Carteret
Site Name: Theodore Roosevelt Natural Area Number: 4
Acres: 290 USGS Quad: Mansfield

Location and Directions

The Theodore Roosevelt Natural Area (TRNA) is located in Pine Knoll Shores. It extends west from Pine Knoll Blvd. for one mile to the Beacons Reach development. The North Carolina Aquarium is located within the natural area. (See Fig. 10)

Site Description

The Natural Area is made up of an extensive dune ridge-swale system, running parallel to the shoreline. Both wet and dry forested swales are found throughout the site. The soils of the area are mapped as Newhan-Corolla Complex, Duckston Fine Sand, Carteret Sand, and Newhan-Urban Land Complex series. The forest is large enough to support several habitat types. The southward leading edge is a Quercus virginiana dominated forest. The canopy is six to eight meters tall and exhibits wind shearing by salt spray. Scattered Pinus taeda are also found in the canopy. The shrub layer is comprised mainly of Ilex vomitoria, Myrica cerifera, and saplings of Quercus virginiana, Quercus laurifolia, and Persea borbonia. There is also much Rhus radicans, Smilax bona-nox, and Vitis aestivalis in this area of the forest. Ground cover is primarily root sucker and seedlings of Quercus virginiana, Quercus laurifolia, and Persea borbonia.

The interior of the Natural Area is dominated by Quercus laurifolia. Pinus taeda and Carpinus caroliniana is also common in the forest canopy with scattered Carya glabra and Juniperus virginiana. The understory is characterized by Persea borbonia, Osmanthus americana, Ilex opaca, scattered Cornus florida, and canopy tree saplings. Ground cover consists of Mitchella repens, Smilax bona-nox, and Rhus radicans.

Also within the interior of the site are several tracts of swamp forest. In these areas the dominant tree species are Acer rubrum, Fraxinus tomentosa, Liquidambar styraciflua, and Magnolia virginiana. The swamp forest occurs in the larger swales and often extends all the way to the sound. As these forested swales extend towards the lee side of the island, they become fresh water marshes, and eventually grade into salt marsh. The dune ridges also extend into the marsh, creating forested peninsulas dominated by Quercus virginiana and Juniperus virginiana.

Evidence of Disturbance

There are no recent disturbances within the forest interior except for natural windthrows. Several old stumps of Juniperus virginiana have been observed, which may indicate selective logging of red cedar prior to the establishment of the Natural Area. Although we could not obtain any records of fire history, the presence of burned stumps provides evidence of past fires in

forest. This may explain the presence of large, even-aged stands of Pinus taeda in the forest (Evans and Lopazanski 1988). The North Carolina Aquarium occupies 25 acres within the forest and maintains an access road from Pine Knoll Blvd. There is also a powerline cut along the eastern portion of the tract and a electrical sub station is located within the forest.

There is a clearing for a shopping center at the southeast corner which has drastically altered the hydrology of the immediate area. An area of swamp forest has been ponded, resulting in the death of many trees. Completion of the shopping mall or other developments in this location will undoubtedly create surface run off into the forest and disturb wildlife habitat.

Ecological Significance

This area is highly significant in that it is a large, contiguous tract (290 acres) containing all the common maritime forest species. It also includes excellent examples of maritime swamp forest and other subhabitats. The pristine sound-side portion of TRNA contains numerous ecotones between the maritime forest and fresh and salt water marshes.

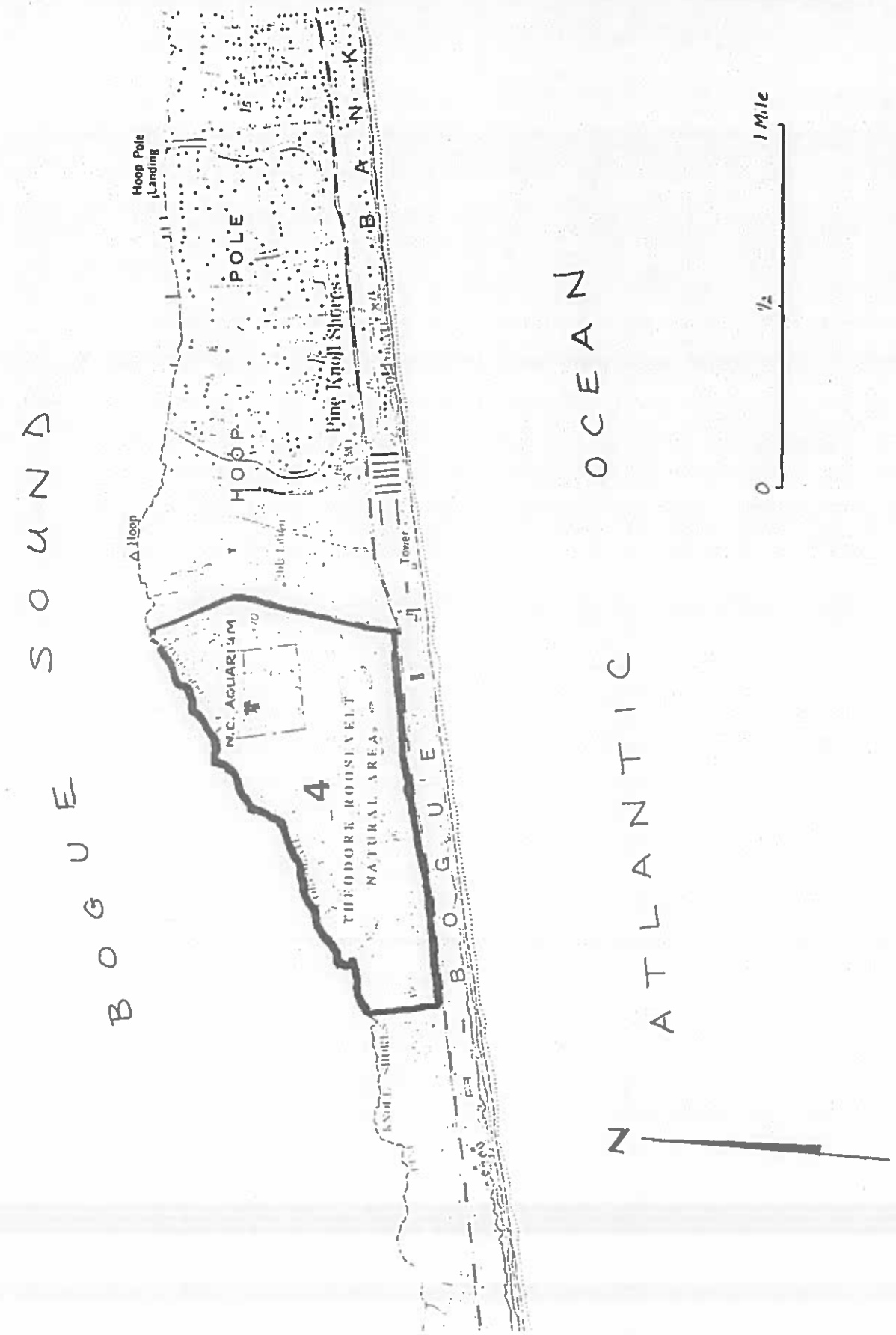
Current Forest Management

TRNA, being a state nature preserve, is managed strictly for its scientific and aesthetic values. Within the 25 acres administered by the Aquarium, there is a maintained nature trail through a small section of the forest. The trail is confined, however, to the dune ridges and elevated platforms are used to tranverse the swamp forest.

The western boundary abuts the Beacons Reach residential development. Although impacts on the forest from the development are low at the present, they are likely to increase with additional clearing to accomodate more houses.

FIGURE 10

Bogue Banks: Forest Site #4 - Theodore Roosevelt Natural Area



FOREST SITE SUMMARY

Island: Bogue Banks
Site Name: Indian Beach
Acres: 33
County: Carteret
Number: 5
USGS Quad: Salter Path

Location and Directions:

The Indian Beach site is located on NC 58, about 0.5 mile inside the town's eastern limit. The forest tract is bounded by the Salter Path and a vacant lot to the west. NC 58 runs along its southern boundary and a man made canal borders its eastern side. The northern side of the tract borders on Bogue Sound and saltmarsh. (See Fig. 11)

Site Description

The topography of the site is characterized by steep dune ridges (10 to 12 meters high) which surround very broad swales. The soils are mapped as Duckston Fine Sand, Fripp Fine Sand, and Newhan-Corolla series. There are two distinct stand types within the forest site. The lower areas (swales) are dominated by a mixed-aged pine forest (Pinus taeda) with Persea borbonia, Carpinus caroliniana, and Cornus florida as the dominant understory species. In the high dune areas Quercus virginiana and Quercus laurifolia are most abundant, with Persea borbonia and Ilex vomitoria common in the understory. No substantial swamp forest is present. More vines (mostly Vitis aestivalis and Smilax bona-nox) are present in the pine forest than on the oak dominated ridges.

Rhus radicans is absent from both stand types, which may indicate a lack of chronic disturbance and a more mature forest. On the dune ridges, Carya glabra is present a small population of Juniperus virginiana which shows considerable mortality. Ground cover consists of Smilax bona-nox, Mitchella repens, and Ilex vomitoria saplings.

Although there is no substantial swamp forest, typical swamp forest species, such as Magnolia virginiana and Hydrocotyle verticillata, were present in one dune depression.

Evidence of Disturbance

There are footpaths along most of the ridges of the forest area many of which see some ATV traffic. There is also a clearing with a crude shelter in one of the swale areas.

Ecological Significance

The site contains a mature maritime forest tract located on an impressive dune ridge-swale system.

Current Forest Management

Indian Beach and Salter Path have a total of about 83 acres of maritime forest. Both of these communities have a history of unplanned and widely scattered development starting at the turn of the century. Little has been done in the past to protect the

natural vegetation of the forested areas. This apparent lack of concern is reflected in current development patterns.

In the 1987 Indian Beach land use plan, however, the maritime forest is recognized as a limited resource that is in jeopardy of being destroyed by increased large-scale development. The plan refers to the value of the forest in terms of aesthetics, shading capabilities, and wind protection.. The policy regarding the remaining maritime forest is to discourage the clear cutting of land; enforce the vegetation protection standards of the zoning ordinance; inform land owners about the value of preserving trees, shrubbery, and ground cover; promote the planting of street trees along Salter Path Rd.; and landscape shopping area parking lots.

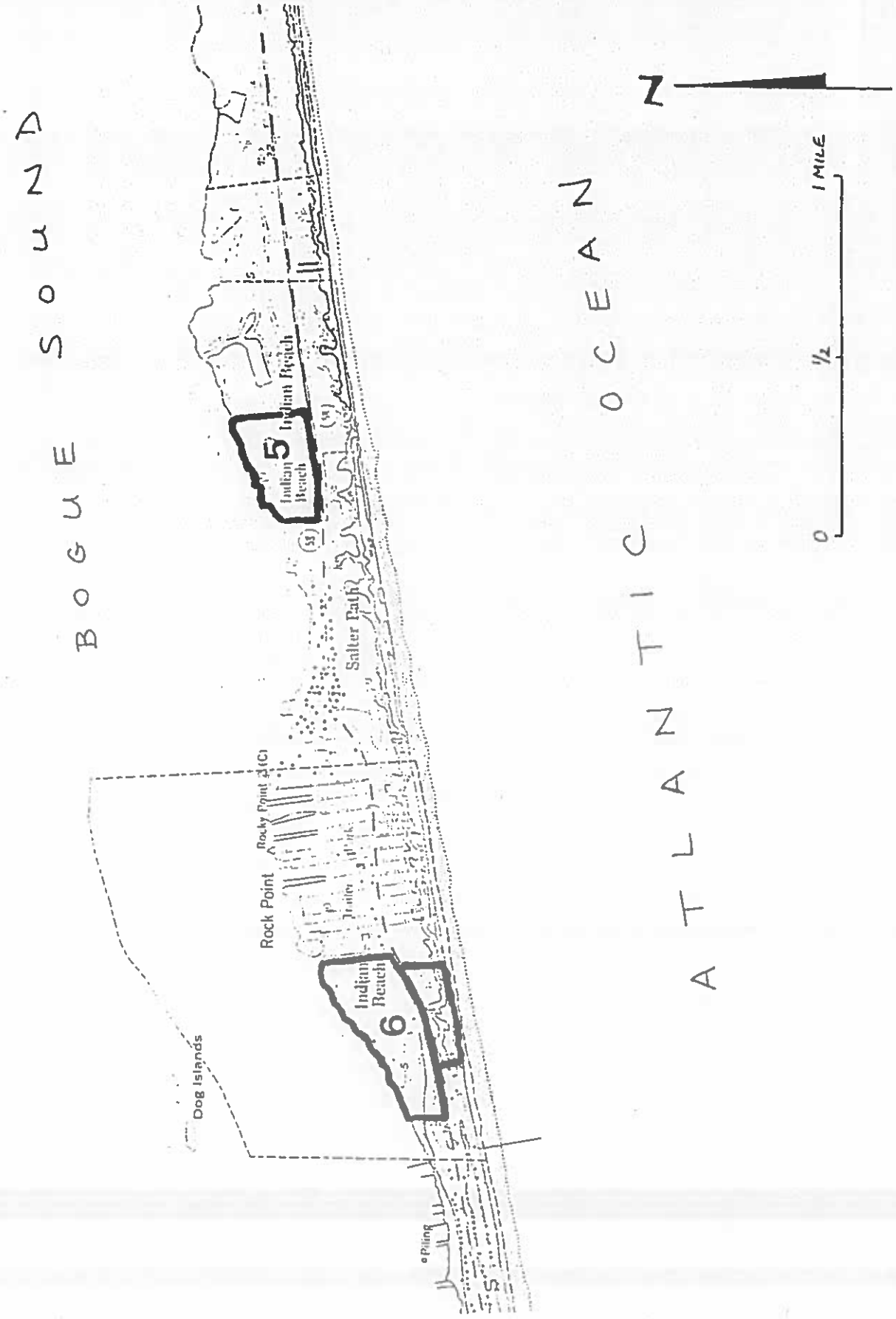
To implement these policies, Indian Beach (and Salter Path) has chosen to limit the amount of vegetation removal. According to the Town's Environmental Protection Ordinance, each developed lot must retain 40% of all trees/vegetation with trunks or main stems greater than or equal to one inch in diameter.

The maritime forest at the Indian Beach site is zoned as a general business district. Under this zoning, small businesses such as convenience stores, professional services, and motels, and parks or picnic areas are permissible. There are no minimum lot sizes under this zoning, but the aforementioned vegetation requirements apply.

Because of the well established foot paths and the shack, the site seems to be treated as a public commons. At present, the area is threatened only by potential development and by increased damage from the footpaths and campsites.

Figure 11

Bogue Banks: Forest Site #5 - Indian Beach
Forest Site #6 - Salter Path



FOREST SITE SUMMARY

Island: Bogue Banks
Site Name: Salter Path
Acres: 50
County: Carteret
Number: 6
USGS Quad: Salter Path

Location and Directions

This site is located on the north and south sides of NC 58, west of and adjacent to the Salter Path Family Campground. The area extends westward to the Bogue Banks Baptist Children's Home. (See Fig. 11)

Site Description

[North Side] The topography is characterized by rolling, hummocky dunes with some low areas of swamp forest. There is no distinct dune ridge-swale system. The soils are mapped as Corolla Fine Sand, Newhan-Corolla Complex, Newhan Fine Sand, and Carteret Sand. The canopy is dominated by Quercus virginiana and Juniperus virginiana. The understory is comprised chiefly of Persea borbonia and Osmanthus americana. Also common in the understory are Carpinus caroliniana, Ilex opaca, and vines of Smilax bona-nox. The ground cover consists of seedlings and saplings of Persea borbonia, Osmanthus americana, Quercus laurifolia, Asplenium platyneuron and Mitchella repens.

A significant feature of the site are the numerous swamp forest and swamp thickets. The swamp forests are dominated by Cornus stricta with an occasional Acer rubrum in the canopy. The northern portions of the forest, before grading into marsh, contain frequent open grassy areas with abundant colonies of ground lichens (Cladonia evansii). There is evidence of selective cutting of Juniperus virginiana in the eastern section of the forest, and there are several foot paths leading from a 20 square meter clearing with a crude structure. The eastern section is dominated by young Quercus laurifolia of 10 to 20cm dbh. There is also evidence of fire throughout this area and the Quercus laurifolia may be regenerating root suckers.

[South Side] This site is located on the south side of NC 58 and together with the area on the north side, creates an undisturbed ocean to sound transect (except for NC 58). The topography of this site is that of a rolling dune system experiencing severe beach erosion. The soils are mapped as Newhan Fine Sand. There is Quercus virginiana/Myrica cerifera scrub immediately behind the foredune. The area is a mosaic of bare sand and salt-stunted vegetation. The "canopy" is no more than one meter high in some places.

Evidence of Disturbance

The western end of the forest is relatively undisturbed but selective cuttings, foot paths, and fire rings increase as one travels east. A crude shelter is also located in the eastern section. Juniperus virginiana was selectively cut from the forest as evidenced by recently cut stumps. There is also evidence of fire in portions of the forest.

Current Forest Management

The Salter Path site has a residential zoning with a minimum lot size of 15,000 square feet. Although this minimum lot size is larger than nearby Atlantic Beach (7,000 sq. ft.), up to 9,000 sq. ft. of vegetation may be removed from each lot. The clearing restrictions will not protect the forest as a whole.

FOREST SITE SUMMARY

Island: Bogue Banks
Site Name: Piney Point
Acres: 50
County: Carteret
Number: 7
USGS Quad: Swansboro

Location and Directions

The site is located in Emerald Isle on the sound side of the island, along the immediate western boundary of the Piney Point subdivision. Heading west on NC 58, access is easiest by making a right onto Lee Ave. The site is bounded to the north by Bogue Sound and to the south by Highway 58. The eastern and western boundaries are the Piney Point subdivision and Live Oak St. respectively. (See Fig. 12)

Site Description

The topography of the site is a dune ridge-swale system with the ridges running parallel to the sound. The ridges are six to eight meters high and those bordering the sound are very steep. The vegetation of the area varies with the topography. Most abundant on the dune ridges are Quercus laurifolia and Quercus virginiana. All the typical maritime forest species are present with an understory dominated by Persea borbonia, Osmanthus americana, and Quercus laurifolia saplings. The ground cover is primarily Quercus laurifolia root suckers/seedlings and Mitchella repens. Pinus taeda is sparse throughout the site, and the forest interior is undisturbed.

Evidence of Disturbance

There is no evidence of disturbance within the forest interior. However, the stand is bordered on either side by housing developments.

Ecological Significance

The most significant features are dune ridges, undisturbed canopy, and swamp forest swales that are located adjacent to the sound and which contain Acer rubrum in the canopy. This site is important because it is a 50 acre tract of undisturbed maritime forest. Large tracts such as this, with undisturbed forest-to-sound ecotones, are rapidly being developed in the Emerald Isle area and will probably disappear within the next five years unless immediate protective measures can be taken.

Current Forest Management

The most heavily forested areas of Bogue Banks are located within the corporate limits of Emerald Isle. The development of Bogue Banks began at the eastern end in the vicinity of Atlantic Beach. Development has since spread westward, and within the last five years Emerald Isle has been the site of several large-scale projects. In spite of the increased development pressure, there are four forest sites located in Emerald Isle. These sites range in size from 50 to 80 acres for a combined total area of 270 acres. The abundance of wooded lots is one of the major draws to the area both in terms of aesthetics and because it is one of the more stable areas on the island on which to build.

The vegetation removal policy adopted by the Town has been to minimize clearing. The amount of land that must remain vegetated on a particular lot depends upon the zoning of the area:

- Residential Districts.....45%
- Low to Moderate Intensity Business.....25%
- High Intensity Business.....15%

Although these percentages are about average for towns with environmentally sensitive development practices, the remaining vegetation does not necessarily have to be natural vegetation. Landscaping may be included in the vegetation percentages. It is a common practice in the business districts to level the entire lot and then landscape the property to meet vegetation requirements.

The Emerald Isle zoning ordinance also states that trees with a diameter of four inches or greater must remain on the property unless they interfere with building construction or access to the property. This provision, however, does not apply in the high intensity business district.

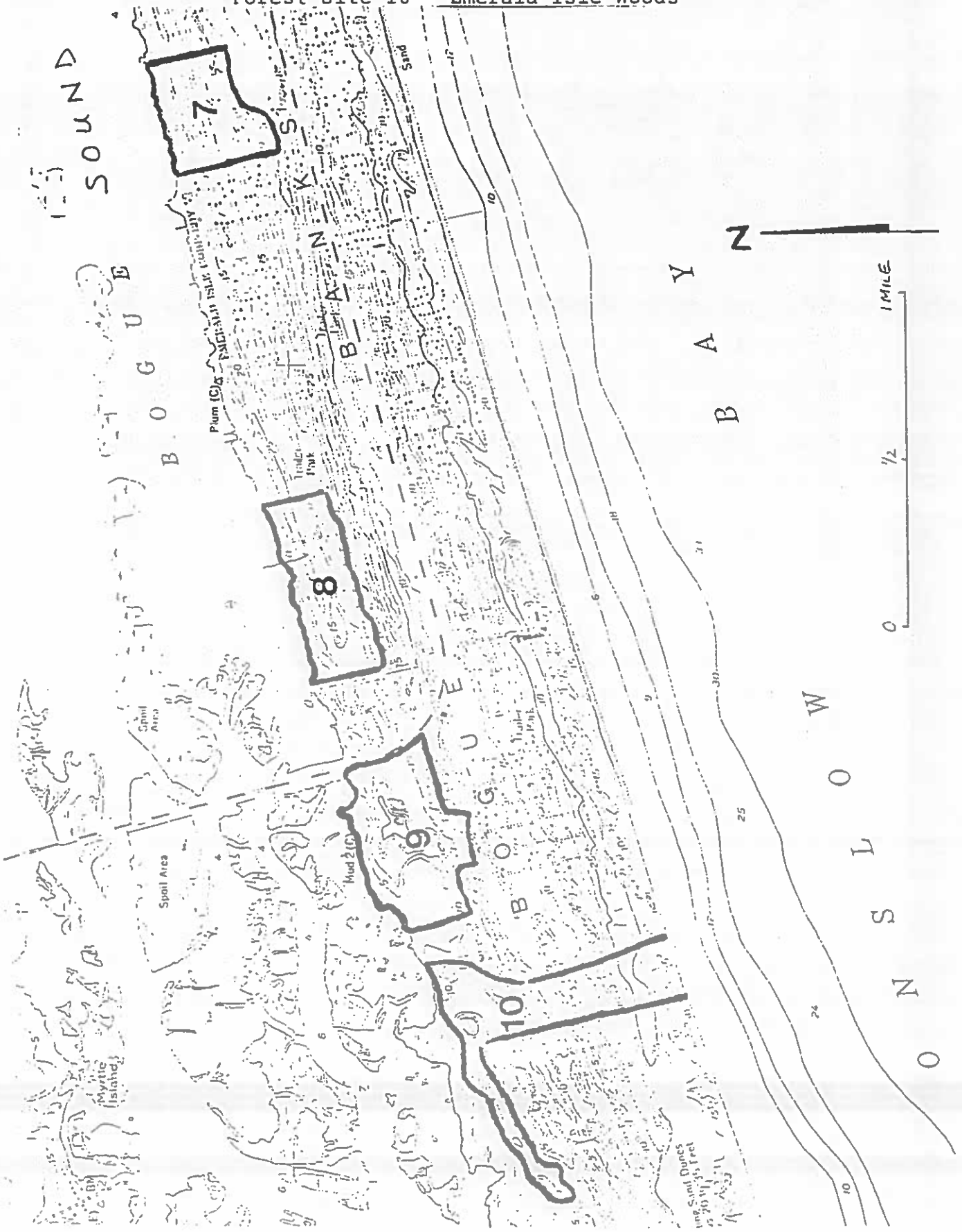
Three forested sites - Piney Point, Emerald Isle Bridge, and Emerald Isle Woods - occur within the residential district which allows single-family, two-family, or multi-family dwellings to be constructed on a lot. The minimum lot size (platted post 1977) is 12,500 square feet, of which 45% must remain vegetated.

The vegetation protection requirements of Emerald Isle are limited. While local zoning regulations help promote the value of vegetation in terms of land stability, water quality, and aesthetics, there are no provisions to protect the naturally occurring vegetation.

Roads from the developments on the western and eastern boundaries of the Piney Point site end at the forest margin. Unless preserved, it will be only a matter of time before these roads meet, and the site is developed.

FIGURE 12

Bogue Banks: Forest Site #7 - Piney Point
Forest Site #8 - Emerald Isle Canal
Forest Site #9 - Emerald Isle Bridge
Forest Site 10 - Emerald Isle Woods



FOREST SITE SUMMARY

Island: Bogue Banks
Site Name: Emerald Isle Canal
Acres: 64

County: Carteret
Number: 8
USGS Quad: Swansboro

Location and Directions

The forest site is located in Emerald Isle on NC 58 just south of the Emerald Isle bridge. It is accessible through the west end of Emerald Isle Plantation. A man-made canal and NC 58 form the western boundary of the site. Partially cleared subdivisions form the eastern and southern boundaries. (See Fig. 12)

Site Description

There is an extensive dune ridge system of intermediate height throughout the site. The soils of the area are mapped as Fripp Fine Sand. The canopy is comprised almost entirely of Quercus laurifolia. Also present in the canopy are Pinus taeda and occasionally Juniperus virginiana. The understory is dominated by a mix of Persea borbonia and Quercus laurifolia saplings. The ground cover consists of Quercus laurifolia seedlings and root suckers, Persea borbonia seedlings, and Smilax bona-nox. Ilex vomitoria is generally absent.

The most significant feature of this area are the old and naturally filled-in swamp forests. These swamps no longer contain standing water, but are wet, high in organic content, and dominated by Acer rubrum. The trees occurring in these old swamps are very large (dbh range from 30-40 cm).

Evidence of Disturbance

There are three overgrown sand roads running through the site. Along these roads are old (3-5 years) cleared subdivisions which are beginning to grow back with pines and other woody species. The roads and subdivisions are located along the south side of the site.

Ecological Significance

A unique characteristic of this forest are the filled-in, late successional swamp forests. This forest is also undisturbed except for the old sand roads and subdivisions in its southern portions.

Current Forest Management

This site is zoned B-3, a high intensity business district. According to the Town's vegetation removal standards, only 15% of the developed site must remain vegetated, either naturally or landscaped. The tree protection ordinance does not apply to this zoning district.

FOREST SITE SUMMARY

Island: Bogue Banks
Site Name: Emerald Isle Bridge
Acres: 80
County: Carteret
Number: 9
USGS Quad: Swansboro

Location and Directions

This site is located at the intersection of NC 58 and the north side of Coast Guard Rd. It extends west along Coast Guard Rd. for approximately 0.7 miles to the Cape Emerald residential development. The southern boundary is Bogue Sound. It is accessible off NC 58 just south of the Emerald Isle Bridge. (See Fig. 12)

Site Description

At this site, there is series of unusually high dune ridges running parallel to the sound. The soils are mapped as Fripp Fine Sand, Corolla Fine Sand, Duckston Fine Sand, and Newhan-Corolla Complex. There are well-developed swamp forests with various levels of standing water. Several areas of old swamp forest have completely filled in through natural processes. The dominant canopy species is Quercus laurifolia with Pinus taeda, Quercus virginiana, and Carya glabra also found in the canopy. Common to the understory are Persea borbonia, Osmanthus americana, Ilex opaca, Cornus florida, and Carpinus caroliniana. Ilex vomitoria is common in the shrub layer as is Smilax bona-nox, Berchemia scandens, and Rhus radicans. Common ground cover consists of sapling Quercus laurifolia, Asplenium platyneuron, and Mitchella repens. The most significant feature of this forest is the steep dune ridge which allows one to look down on the rest of the forest. There is also an extraordinary 12-to-15 meter dune within the forest. A deep water pond with emergent aquatic vegetation exists near the high dune.

Evidence of Disturbance

There are no human caused disturbances within the forest interior other than occasional survey flagging. Several burned stumps were observed providing evidence of past fire.

Ecological Significance

This site is of tremendous ecological value due to the great diversity of community types within one forest area. The lack of disturbance and the interesting topography make this area an outstanding example of the once extensive Emerald Isle maritime forest. It is imperative that this site be preserved at all costs.

Current Forest Management

The area is currently zoned RMH, a residential district allowing single-family, two-family, and multi-family dwellings, as well as motels and hotels. The minimum lot size for this area is 7000 square feet.

The possibility of future subdivision (survey flagging already present) threatens this site as does pressure from

surrounding land uses. The Cape Emerald development has already altered the hydrology along the western boundary where the construction of tennis courts has impounded a section of swamp forest.

FOREST SITE SUMMARY

Island: Bogue Banks
Site Name: Emerald Isle Woods
Acres: 75
County: Carteret
Number: 10
USGS Quad: Swansboro

Location and Directions

The site is located in Emerald Isle, immediately west of the Cape Emerald development on Coast Guard Rd. Beach Cottages form the eastern and western boundaries while Bogue Sound and the Atlantic Ocean form the northern and southern boundaries. (See Fig. 12)

Site Description

This site is all that remains of the 500-acre "Emerald Isle Woods" forest tract as described by Fussell and Wilson, (1983). This tract is the last undisturbed ocean-to-sound transect in the Emerald Isle area. The topography of the seaward section is a rolling dune system which abruptly changes to a flat, poorly drained area as one continues north. The soils of the area are mapped Newhan-Corolla Complex, Fripp Fine Sand, Duckston Fine Sand, and Corolla Fine Sand.

On the north side of Coast Guard Rd. there is a dune ridge system that includes a 10m dune. A Quercus virginiana/Juniperus virginiana thicket dominates the seaward section of the dunes. Behind the dunes is a Quercus virginiana dominated forest which abuts a swamp forest area. The swamp is dominated by Cornus stricta with Acer rubrum occasionally found in the canopy. Salix caroliniana is also found in the swamp forest. The area leading north to Coast Guard Rd. is a mosaic of wetland habitat and hummocks dominated by Quercus virginiana and Quercus laurifolia. The understory of the hummocks is typically Persea borbonia, Osmanthus virginiana, and Ilex opaca. Ground cover on the higher ground consists of Rhus radicans, Smilax bona-nox, Parthenocissus quinquefolia, Asplenium platyneuron, and Mitchella repens. Quercus laurifolia is most abundant on the sound side strip. Numerous Pinus taeda and Carya glabra are also found in the canopy. The most common shrub throughout the site is Ilex vomitoria.

Evidence of Disturbance

Most of the site consists of undisturbed wetland with some foot paths throughout the upland dune areas. The areas of mature maritime forest are partially disturbed by numerous survey lines and lot clearings.

Ecological Significance

The most significant areas are the abundant wetlands and the live oak shrub thicket. It is unusual that such extensive wetlands have developed in such close proximity to the frontal dune. The frontal dune area is undeveloped, allowing an intact, undisturbed ocean to sound transect of the island.

Current Forest Management

The area is currently zoned RMH, a residential district allowing a single-family, two-family, and multi-family dwellings, as well as motels and hotels. The sound side strip is threatened by future subdivision as indicated by by the numerous cleared lots and survey lines. The sheared live oak forest is also threatened by development similar to that of the surrounding beach areas.

The wetlands in this area are the most common physical feature. Development of any sort would most likely alter the hydrology of the area, thereby impounding or draining some of the wetland habitat.

HUGGINS ISLAND

History of Forest Use

Huggins Island, located near Bogue Inlet and south of Swansboro, was first used as a military outpost by North Carolina Defense Troops during the Civil War. An earthen works fort was built on the south side of the island in 1861 to protect Bogue Inlet and the port of Swansboro. The fort had six cannons and was garrisoned by 200 Confederate troops. In March of 1862, the troops, guns, and ammunition were ordered to New Bern to confront a Union attack. The Huggins Island fort was abandoned and later burned by Union Colonel Thomas G. Stevenson in August of 1862 (Swansboro Historical Society Historic Guide and Archives 1983).

The island was not reinhabited until 1887 when it was purchased by Daniel Heady Russell. A two-story house was built near the center of the island and approximately 90 acres were cleared and farmed until 1918 when Russell retired. In addition to corn and other vegetable crops, hogs were also raised on the island. The Russell house and property were subsequently used as a vacation retreat by various owners until the late 1930s when the house was burned (Mrs. Daisy Smith Moore, pers. comm. 1988). Today, the completely forested island is in private ownership, and remains undeveloped.

FOREST SITE SUMMARY

Island: Huggins Island
Site Name: Huggins Island
Acreage: 100

County: Onslow
Number: 1
USGS Quad: Swansboro

Location and Directions

Huggins Island is located near Bogue Inlet, approximately 1.5 miles northwest of Bogue Banks and 0.75 mile southwest of Cape Carteret. The island is most easily accessible by canoe launched from the NC 24 bridge. (See Fig. 13)

Site Description

The topography of the island is generally flat. The sides of the island leading up from the marsh are steep and about one to two meters high. Although the soils of the island are mapped as Newhan-Urban Land Complex, the soils that were actually observed were a reddish brown fine sand. Soil depth was in excess of 20 cm and was very rich in humus.

The northwest section of the island is dominated by Pinus taeda, Quercus virginiana and Juniperus virginiana. The area is fairly open with many large trees of various species. The understory and shrub layer is predominantly Quercus laurifolia. Also common in the canopy is Quercus falcata. As you travel south it becomes evident that Juniperus virginiana is dying out and being overtopped by Pinus taeda. There is much Ilex vomitoria in the understory as well as Osmanthus americana, Prunus serotina, and Persea borbonia. The Smilax species was grazed and there were old wire fences laying about.

The middle part of the island is dominated by Juniperus virginiana. The understory is again dominated by Quercus laurifolia. The westward notch in the island has a salt marsh grading into freshwater marsh and swamp forest dominated by Acer rubrum. On the west side of the south shore is the site of a former Civil War fort. Quercus virginiana is the most abundant canopy species in this area. Also common to the canopy in this area is Quercus laurifolia and Prunus caroliniana. The eastern-most point of the island is dominated by Quercus laurifolia. It is in this section that there is a large patch of Sabal minor.

Evidence of Disturbance

There is no evidence of immediate disturbance on the island except along the northern shore where there are several campsites. Accompanying these campsites are the usual trash and fire rings. There is also an abandoned well and several piles of old decaying bricks in the same vicinity. Deer scat was observed near the swamp forest indicating that the forest is grazed by a small deer population.

Old wire fencing was observed on various parts of the island. It was found in lengths in excess of 15 meters. This is visual evidence that the island was once cleared and used for farming and grazing. The abandoned fields were initially

recolonized by Juniperus virginiana which are now dying, having been over-topped by pines and hardwoods in the usual successional pattern.

Ecological Significance

This relatively undisturbed maritime forest is located on an island in one of the most rapidly developing sections of the North Carolina coast. It is a fine example of maritime forest community on a sound side island. This type of forest development is rare along the North Carolina coast because the larger sound side islands, such as Harkers Island, have been cleared for development.

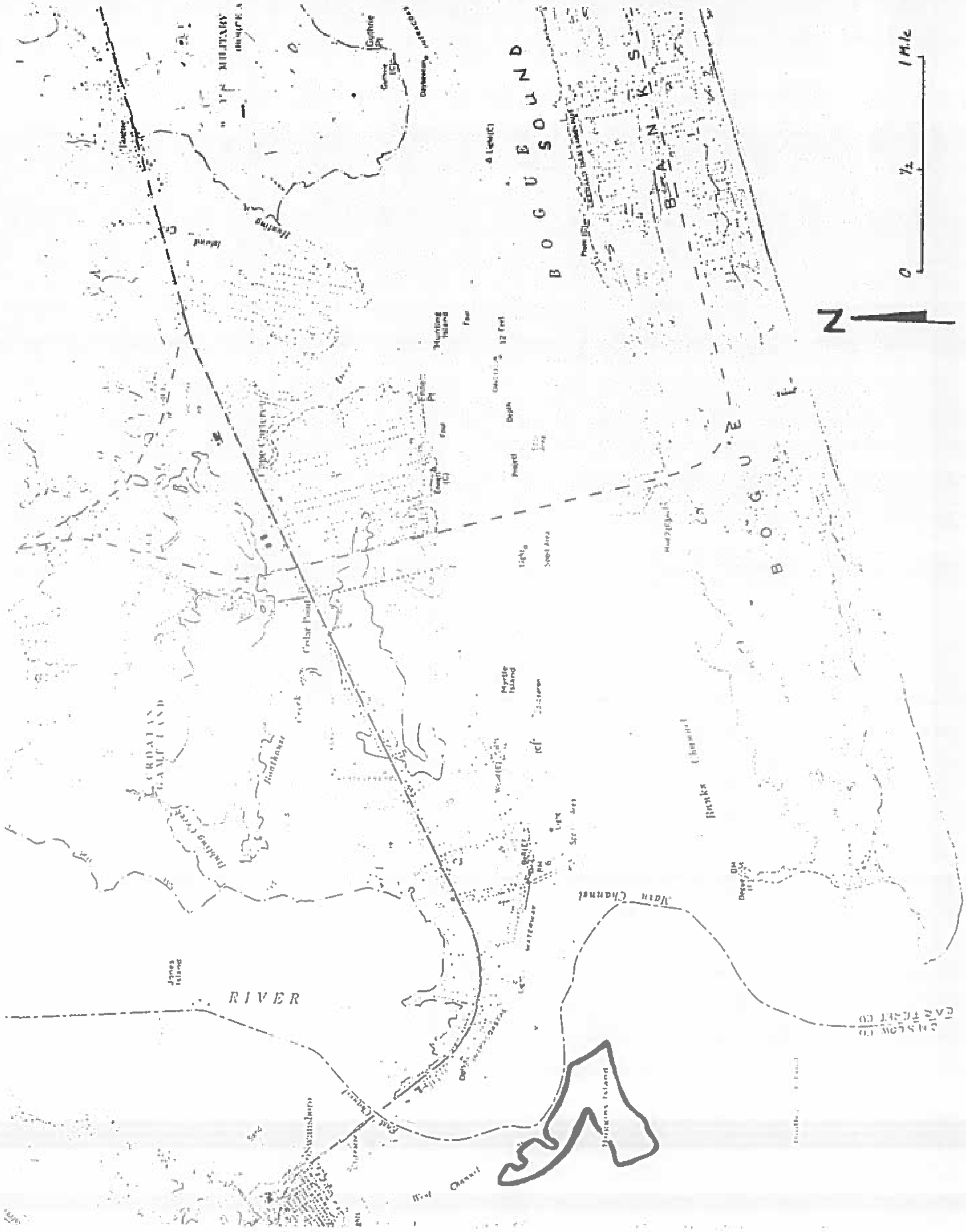
The island has many large old trees of various species in addition to a significant stand of swamp forest. There is also a large patch of old Sabal minor.

Current Forest Management

The island is under the jurisdiction of the Town of Swansboro and currently has no zoning. However, it is classified Conservation in the Onslow County Land Use Plan. Development may occur in these areas provided that it is limited to low density residential housing, piers, docks, or marinas. Development proposed within areas classified Conservation must be approved by the Onslow County Planning Board, and is subject to site specific development guidelines. Low density residential development in Onslow County is currently considered to be lot sizes of at least 40,000 square feet.

FIGURE 13

Huggins Island: Forest Site #1 - Huggins Island



BEAR ISLAND

History of Forest Use

Bear Island is a relatively small (892 acres) east-west oriented island located in Onslow County. The island extends from Bogue Inlet, 3.5 miles west to Bear Inlet. The island is accreting on the ocean side, which has contributed to its relative stability and the maintenance of a large active dune system (Pilkey et al. 1980). Access to the island is from the sound side via a maze of natural channels through extensive salt marshes.

Before the arrival of the first European Settlers, Bear Island was used for hunting and fishing by Native Americans such as the Neusiok and Coree tribes. Earliest records indicate that in 1749, a fort was built on the western end of the island to protect the area from pirates (Scott 1988). This fort was evacuated and burned in 1862 during the Civil War. Another building was constructed on the ;island by Captain Daniel Hardy and his family during the 1800s to process whales and porpises for their oil and other products. The island was also used in the 1800s as a cotton and peanut plantation during the early 1800s (Schoenbaum 1982).

After the Civil War, the island plantation was abandoned and replaced by smaller-scale farming until its purchase by Dr. William Sharpe in the 1920s (Schoenbaum 1982). He moved a house to the island - then known as "The Hammock" - for use as a vacation home. In 1950, Sharpe willed the entire island to the North Carolina Black Teachers Association (NCBTA) (Schoenbaum 1982). The State would not fund a bridge or other projects for a black recreation area and the island remained largely undeveloped. In 1961 the NCBTA gave the island to the state to be used as a state park (Schoenbaum 1982).

Today, the island is host to Hammocks Beach State Park and is still only accessible by private boat or park ferry. The island has remained in a natural condition with the only man-made disturbances being a ferry landing with a paved path leading to the beach pavillion and a few service buildings. The park serves an average of almost 30,000 visitors each year (Scott 1988). Maritime shrub thicket occurs over all the island interspersed among the dunes that offer protection from wind and salt spray. An area of maritime forest exists at the eastern end of the island on the sound side. The forest is relatively small and free of anthropogenic disturbances, but is being slowly buried by an active dune system. Considerably more forest existed on the island earlier in this century. Fire or some other disturbance led to the destabilization of the dunes across the island and the subsequent burial of much of the forest. The actual history of these disturbance events is currently unknown.

FOREST SITE SUMMARY

Island: Bear Island
Site Name: Hammocks Beach
Acreage: 70

County: Onslow
Number: 1
USGS Quad: Swansboro

Location and Directions

Hammocks Beach is located in Onslow County approximately five miles south of Swansboro between Bear and Bogue Inlets. Access is by public ferry operated by the NC Division of Parks and Recreation (June 1 through Labor Day) off NC 24 and SR 1511. (See Fig. 14)

Site description

The maritime forest is located at the eastern end of Bear Island, behind an active dune field. Although protected from wind and salt spray by massive dunes, the leading edges of the forest are being buried as these dune migrate across the island. The topography of the site ranges from the steep incline of the dunes, to a series of small dune ridges running parallel to the sound. The soils of the area are mapped as Newhan Fine Sand and Duckston Fine Sand.

The forest canopy is dominated by Quercus virginiana, Quercus laurifolia, and Pinus taeda. Less frequent in the canopy are Nyssa sylvatica and Juniperus virginiana. The understory species include Persea borbonia and Ilex opaca. Carpinus caroliniana is well represented in the understory but it has a depauperate seedling population. Some of the broader swales have areas of swamp forest which have a canopy dominated by Acer rubrum. Mitchella repens, and Quercus virginiana seedlings are common ground cover. The most common vines in the area are Smilax bona-nox and Rhus radicans.

Evidence of Disturbance

Deer scat was observed in the forest and Smilax bona-nox and Rhus radicans appeared to be grazed. However, the overall effect of these animals on the forest as a whole appears to be minimal. The major disturbance affecting the forest is the extensive dune encroachment.

Ecological Significance

Bear Island is one of the few islands along the North Carolina coast that remains in an almost completely natural state. Public access is limited and use is confined primarily to the area of the concession stands and the beach. The forest itself has seen little if any human disturbance; Charred stumps are remnants of a fire caused by lightning in 1945 (Scott 1988). The encroaching dunes provide an excellent example of the dynamic conditions under which maritime forests exist (see Part I). There are also no feral animals on the island.

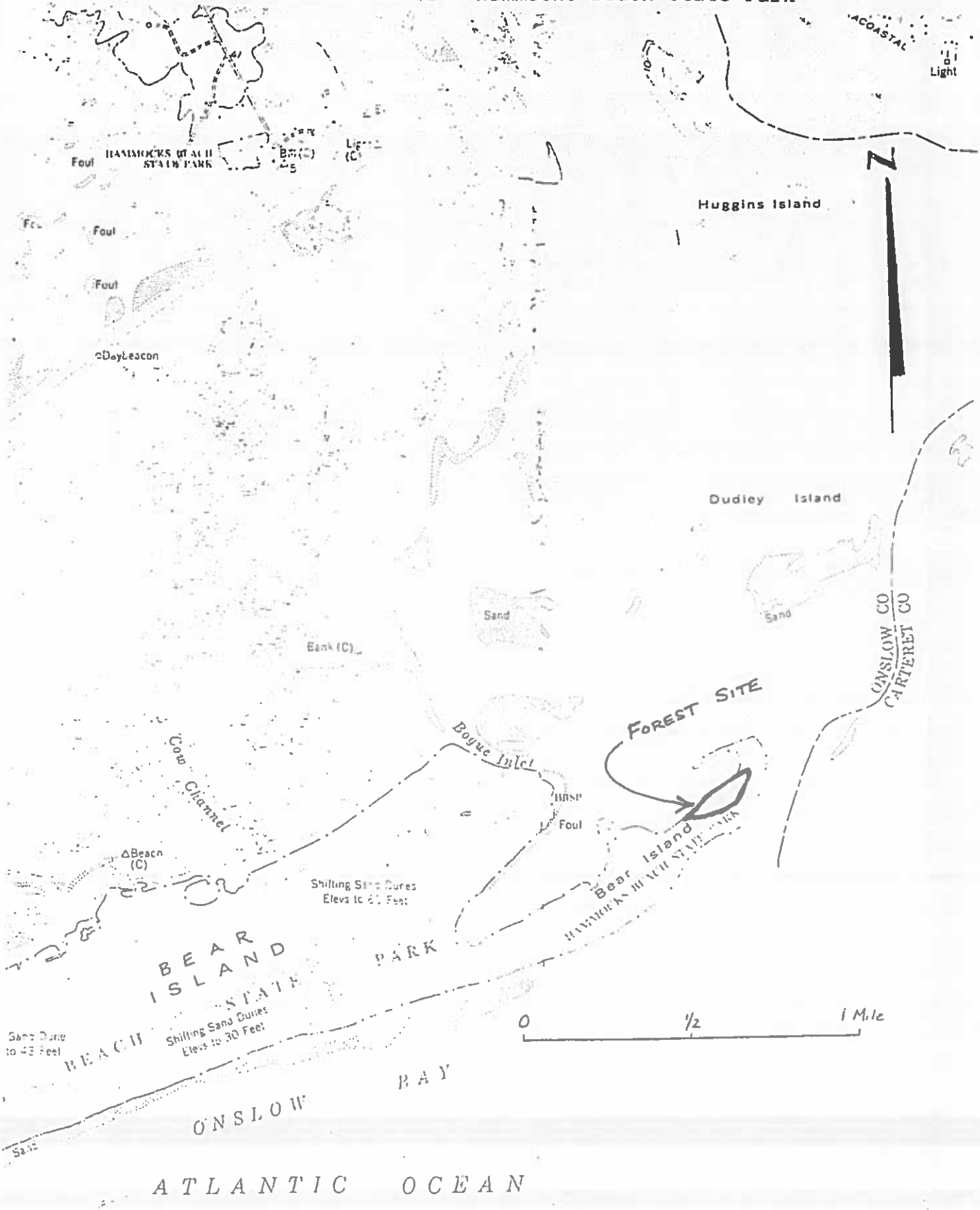
Current Forest Management

Bear Island (Hammocks Beach) is managed as a state park and natural area by the North Carolina Division of Parks and

Recreation. The area is to be used for swimming, fishing, hiking, and camping at designated sites. Facilities include ferry service to the island and a concession stand with restrooms and changing facilities. Several maintenance buildings and an education center are also in close proximity to the ferry landing near the center of the island. The forest, located on the eastern end of the island, is not managed in any way. Unless the migrating dunes become stabilized, this forest tract will continue to dwindle in size with time.

FIGURE 14

Bear Island: Forest Site #1 - Hammocks Beach State Park



TOPSAIL ISLAND

History of Forest Use

Topsail Island is the second largest of North Carolina's barrier islands south of Cape Lookout. It stretches for 24 miles between the New River Inlet and New Topsail Inlet. The military was the first to officially occupy the island in the early 1930s, and residential development followed soon after.

The man considered responsible for the development of Topsail Island is A.H. Ward. He and his sons are the owners of A.H. Ward Realty which has been operating in the area for the past 41 years. According to Mr. Ward, Ward Realty built the first 25 homes on Topsail Island.

Although much of the island was forested in the past (Pilkey et al. 1980), the remaining forest (as can be viewed from aerial photographs), is now punctured by homes and roads. During hurricane Hazel in 1954, 91% of the buildings on the island were destroyed (Pilkey et al. 1980). According to Pilkey et al. (1980), the island was developed rapidly and in an unsound manner which included the leveling of dunes and excess clearing of vegetation.

The 1987 Land Use Plan for Surf City states that: "The major value of maritime forest is aesthetic, although it is an important component of the barrier island ecosystem that provides wildlife habitat and helps to stabilize the soil and sand." Nevertheless, there has been no apparent attempt to preserve maritime forest habitat on Topsail Island.

One to two miles south of the northern NC 210 bridge, there is a tract of forest which provides an excellent example of salt shearing of coastal vegetation. The interior of the forest, however, is punctured by lot clearings and access roads. The fragmentation of the forest can be observed along NC 50, and continues in the same manner through Surf City. At the widest part of the island, south of Surf City, several remnant live oak forest tracts can be found. These forests are highly fragmented due the high density of homes in this area. Only one area of undeveloped maritime forest remains on the island. At the present time, only one home has been built there, but sand roads, fire hydrants, and electric power boxes all provide evidence of impending development.

FOREST SITE SUMMARY

Island: Topsail
Site Name: Pirates Cove
Acres: 54

County: Onslow
Number: 1
USGS Quad: Holly Ridge

Location and Direction

This site is located in Surf City, three miles south of the northern NC 210 bridge, on the sound side of NC 50. Access is by way of a sand road that cuts back into the forest. The Island Oaks residential development makes up the northern boundary while Pirate's Cove delineates the southern boundary. The western limits are along the sound, and NC 50 lies to the east. (See Fig. 15)

Site Description

The topography of the site is generally flat with a few low dune ridges. The area slopes slightly upward towards NC 50. A sand road runs through the forest and ends at a private residence. There are electrical transformers at various sites as well as fire hydrants along the roads.

The most abundant canopy species in the tract are Quercus virginiana and Juniperus virginiana. The oaks are partially buried and are similar in morphology to the oaks on Shackleford Banks. The Quercus laurifolia in the forest is young (10-20 dbh) and is coming up straight. The understory is similar to that of the forest found on Bogue Banks. The dominant trees here are Persea borbonia and Osmanthus americana. Ilex vomitoria is also abundant in the understory. Smilax bona-nox and Rhus radicans are common in the shrub layer but not overly abundant. Ground cover consists mostly of leaf litter, Quercus virginiana seedlings/root suckers and Mitchella repens. There is a small area of swamp forest located on the north side of the sand road in which Salix caroliniana, Prunus caroliniana, and Magnolia virginiana are present. Most of the live oak and red cedar are quite old; (one particular Quercus virginiana had a 72cm dbh). They also appear to being dying out and are being replaced by Quercus laurifolia.

Ecological Significance

This site is of interest because it is the last substantial tract of intact maritime forest remaining on Topsail Island. The site also contains old growth Quercus virginiana and Juniperus virginiana.

Current Forest Management

The Town of Surf City recognizes maritime forests as fragile areas vulnerable to development (Surf City LUP, 1987). The forest is considered significant in its aesthetic qualities, wind protection capability, and land stabilizing ability. The Town's policy towards this fragile area is to "...encourage the maintenance of existing maritime forests by allowing only that development that will cause the least practical disruption to the forest cover."

According to the land use plan, the Town encourages planned unit development in maritime forests, allowing the transfer of density on a site which permits reasonable use of the property and while still protecting the vegetation. Maritime forests have also been designated as a Conservation Overlay Zone in which multi-family development is only permitted as a conditional use. The Town requires a site plan for any development over four dwelling units.

Although the above policies reflect a concern with the maintenance of the natural vegetation, Town ordinances include only basic restrictions on vegetation removal. There are no ordinances regulating the removal of trees of a certain diameter.

The last significantly forested area of Topsail Island is located within Surf City. The zoning of this area was recently changed from residential lots with a 10,000 square foot minimum lot size to residential lots of 5,000 square feet and an allowable density of 8 units per acre. According to the Town's inspections department, nearly 75% of the vegetation may be cleared from each lot, with no provisions for tree preservation.

The planned density of development in this area is one of the highest of all the sites surveyed. If the remaining maritime forest of Topsail Island is to be protected, the zoning ordinances must be made more environmentally sensitive. Ordinances are needed that will limit the removal of trees and/or require a larger percentage of the lot to remain vegetated.

FIGURE 15

Topsail Island: Forest Site #1 - Pirates Cove

CAPE FEAR

History of Forest Use

Cape Fear is the southernmost cape in the North Carolina barrier island chain. It extends from New Inlet to the mouth of the Cape Fear River. The Cape comprises approximately 13,000 acres of beach, dunes, maritime forest, and marsh. Of this land, 1900 acres support maritime forest vegetation (Mayes 1984).

Three islands make up the Smith Island complex at Cape Fear. These islands are Bluff Island, Middle Island, and Bald Head (Smith) Island, from north to south respectively. The three-island complex may have formed as a result of spit elongation due to an ample offshore sand supply and other oceanic processes. This is evidenced by the progressive age of the upland soils from south to north, and the pattern of upland ridges (Parnell and Adams 1970). It is also theorized that the islands resulted from river deltaic deposition, with the rise and fall in sea level moving and exposing the sediment ridges (Leatherman et al. 1982).

Prior to the arrival of European settlers, the islands (Bald Head in particular) were used extensively by Native Americans for hunting and fishing, although they had no permanent settlements there. It was not until 1664 that the first permanent settlement was established by Europeans on Bald Head, the largest and southernmost of the islands (Stick 1985). However, Bald Head Island was abandoned several times, and was not permanently inhabited until the early 1700s (Mayes 1984). The island was used only for hunting and fishing until 1882 when a life saving station was built to aid mariners wrecked on the Cape Fear shoals. Recreational development began on Bald Head in 1914, but it was not until the early 1970s that significant housing development occurred.

During the Civil War, a fort was built by the Confederates to protect blockade runners entering the mouth of the river to reach the port of Wilmington. Palmetto (*Sabal palmetto*), red cedar (*Juniperus virginiana*), and flowering dogwood (*Cornus florida*) were all logged from the island. For a time, Bald Head Island was one the world's leading source of pencil wood with approximately one million feet of red cedar being cut for the manufacture of pencils over seas. As a result of the intense logging, large mature cedars are almost absent from the forest. Bald Head Island was also an important source of live oak (*Quercus virginiana*) which was prized for ship building (Stick 1985). The island was grazed by domestic animals, primarily hogs, until their removal in the 1970s.

The islands came under single ownership in 1963 when Frank O. Sherrill acquired the remaining federal lands of the abandoned lighthouse. This was the first time that the Smith Island Complex was owned by one person since 1789 (Stick 1985). Sherrill was responsible for initiating the planned development of Bald Head Island. He envisioned the complete development of

the island including the marshes, so as to accommodate a population of 60,000. These plans caused much public outcry which hampered Sherrill's progress. He then sold his property rights to the Carolina Cape Fear Corporation in 1970 for 5.5 million dollars, despite attempts by The Nature Conservancy and the State of North Carolina to purchase the island (Stick 1985).

By 1972, construction of a golf course and the Bald Head Inn had begun and the Carolina Cape Fear Corporation had filed for permits to build a marina and ferry terminal adjacent to the Cape Fear River. Construction of the golf course resulted in the destruction of 760 acres of the maritime forest. In 1974, the Corps of Engineers issued the permit to build the marina facilities with the provision that the Carolina Cape Fear Corporation deed to the State approximately 75 percent of the Smith Island properties. This included not only marshland, but also six miles of beach on the eastern shore, Bluff Island, and several other smaller islands which were important shorebird rookeries (Stick 1985).

Because of severe delays, and the economic recession of the mid-1970s, the Carolina Cape Fear Corporation went bankrupt in 1976. The Builders Investment Group, a major investor in the Carolina Cape Fear Corporation, found themselves the new owners of the Bald Head Island properties (Stick 1985). It was during their ownership that the Bald Head Inn was opened for business and ferry service began out of Southport.

In 1979, Middle Island was sold to Charles Young for $475,000 and the rest of the Bald Head properties were sold to Cambridge Properties. During 1982, the company began work on the marina and ferry terminal which would provide a direct route across the river to the island. It was also under the ownership of the Cambridge Properties that a Carolina Power and Light Company cable was laid beneath the Cape Fear River to provide electricity to Bald Head Island (Stick 1985).

The island changed hands once more in 1983 when it was sold to George Mitchell and the Bald Head Island Limited Company. Since his purchase, Mitchell has proceeded with development of the island according to plans similar to those of Cambridge Properties. The entire western third of the island is now developed with a golf course, beach homes, and townhouses. The marina is now complete, phone service is available via microwave antenna, and paved roads (for golf carts only) wind their way around the development and into future sites.

The town of Bald Head Island is soon to be incorporated but there is currently no land use plan available. The entire island has been subdivided into lots ranging from 10,000 to 15,000 square feet. The proposed Bald Head Island Village on the east end will seriously alter a large tract of undisturbed maritime forest. Survey lines can be found across the entire island, and phase two of the development plan has already begun on the dunes east of the golf course. Bluff Island is state owned, and will

be managed as a natural area. Middle Island has been subdivided and lots have recently been cleared.

FOREST SITE SUMMARY

Island: Cape Fear
Site: Bluff Island
Acres: 70

County: Brunswick
Number: 3
USGS Quad: Cape Fear

Location and Directions

Bluff Island is the northernmost of the three islands making up the Smith Island complex of Cape Fear. It is accessible by crossing a private boardwalk along the road leading from Bald Head Island. The island is surrounded by marsh on its northern, southern, and western boundaries. Along its eastern boundary is a dune system and active beach. (See Fig. 16)

Site Description

There is little topographic relief on the island. Two dune ridges run down the middle of the island, but the land around them is generally flat. The island's forest is quite thin. Where there is a canopy, the most abundant species are Quercus virginiana, Quercus laurifolia, Sabal palmetto, and Juniperus virginiana. The undergrowth is dense and impenetrable in some places. Smilax bona-nox, Rhus radicans, and Lonicera sempervirens are the most prevalent vines and almost cover the shrub layer. The dominant understory species are Persea borbonia, Prunus caroliniana, Osmanthus americana, Carpinus caroliniana and Ilex opaca. Common in the shrub zone are Ilex vomitoria, Myrica cerifera, and Calicarpa americana. There is a trail across the island which terminates at a fresh water pond dominated by Phragmites. Many of the Quercus virginiana and Osmanthus americana individuals are quite large. The ground cover is comprised of Asplenium platyneuron, Mitchella repens, and Sabal minor which is most abundant along the edges of the forest.

Evidence of Disturbance

The disturbance of the canopy is probably due to frequent storms which causes windthrows. Once the canopy is opened, the increased light conditions promote rapid growth of the understory species and vines. The frequency of storms create a constant state of mid to late successional development in the forest. There is a well-defined footpath which crosses the island and a boardwalk across the surrounding marsh.

Ecological Significance

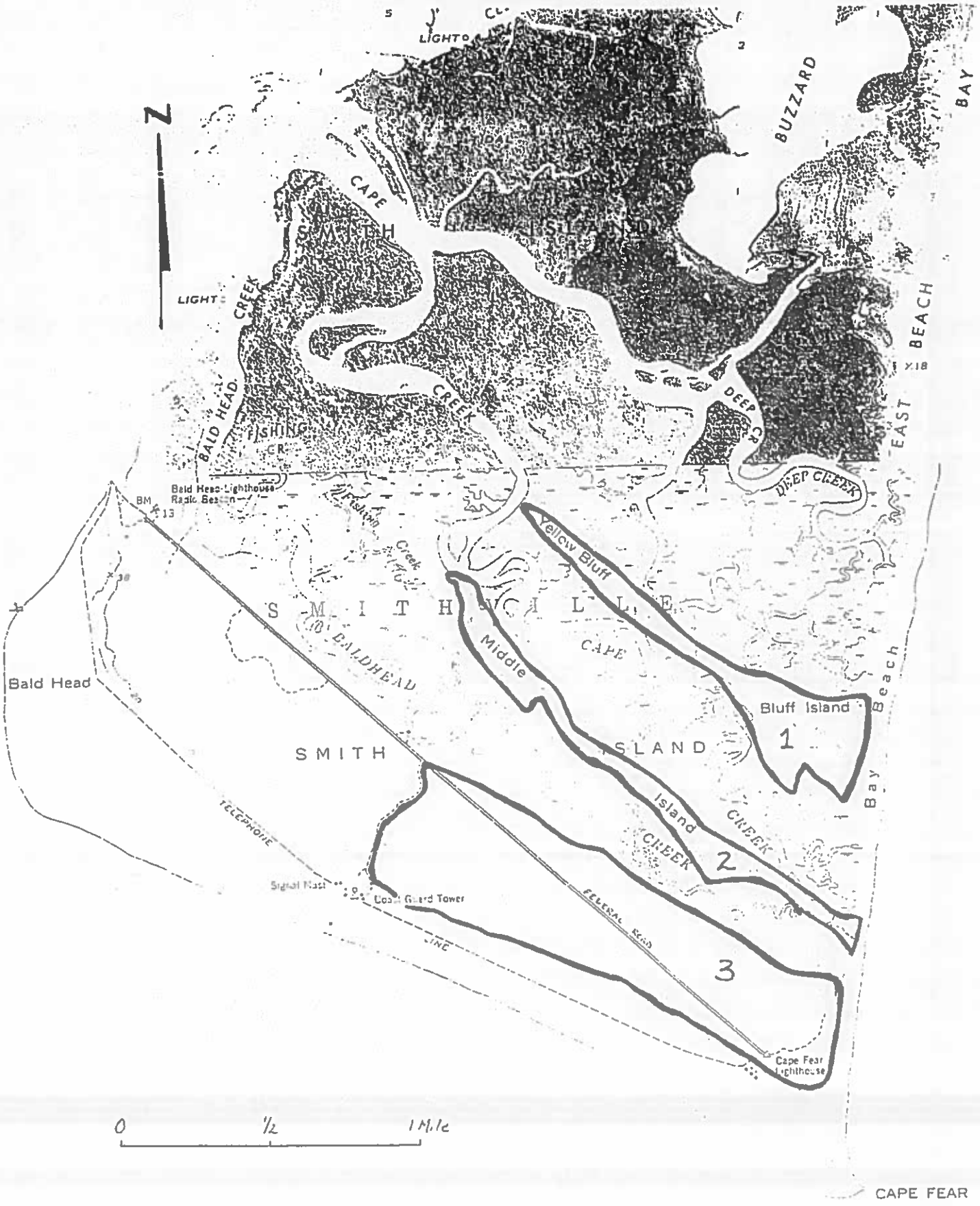
The entire island is in a natural condition, and being the northernmost of the three island complex, offers unique comparison opportunities. The fresh water pond is significant because of its proximity (less than 100m) to the active beach.

Current Forest Management

Bluff Island is the smallest and northernmost of the three islands. Although the land is state owned, it is not actively managed. The Division of Parks and Recreation patrols the beach and upland spit (East Beach).

FIGURE 16

Cape Fear: Forest Site #1 - Bluff Island
Forest Site #2 - Middle Island
Forest Site #3 - Bald Head Island



FOREST SITE SUMMARY

Island: Cape Fear
Site Name: Middle Island
Acres: 100
County: Carteret
Number: 2
USGS Quad: Cape Fear

Location and Directions

Middle Island is located between Bluff Island and Bald Head Island in the Smith Island complex. The island is accessible by road from Bald Head Island. The entire island is privately owned and is surrounded by marsh except for the area of the access road at East Beach. The access road has a locked gate and there is a home at the entrance. (See Fig. 16)

Site Description

The island encompasses two to three dune ridges. These ridges become more pronounced at the western end of the island. The entire island is bisected by a road about 8m wide. The canopy of the forest is very sparse and the undergrowth quite dense. The most abundant and largest of the tree species present is Quercus virginiana. The thin canopy also contains some large examples of Quercus laurifolia. Sabal palmetto and Carya glabra are also present in the canopy. A stand of Pinus taeda occurs at the north central side of the island. The understory species present are Persea borbonia, Osmanthus americana, Prunus caroliniana, and Ilex opaca. The shrub layer consists of Ilex vomitoria and a thick assemblage of vines (Smilax bona-nox, Rhus radicans, and Lonicera sempervirens). The common ground cover species are Asplenium platyneuron, Galium hispidulum, and Mitchella repens.

Evidence of Disturbance

Middle Island is similar to the other islands of the Smith Island complex. Frequent storms seriously disturb the canopy, causing increased light conditions which promotes dense undergrowth. There is a main road which bisects the island, and ends at a private boat ramp and dock. There are two loops off the main road. Half of the island has been subdivided as is evidenced by numerous lot clearings and survey lines. The roads cause a major disturbance in the canopy. There is also a dug out pond on the island.

Ecological Significance

Although the island is being developed, enough of it remains in a natural condition to merit its protection as an excellent example of maritime forest with subtropical elements.

Current Forest Management:

Middle Island is subdivided into lots of approximately 10,000 square feet. The island is quite narrow and the building sites will occupy a significant portion of the dune ridge area. This island will be within the jurisdiction of the future Town of Bald Head Island, and the same building regulations and vegetation restrictions will apply. However, Middle Island is considerably smaller (100 acres) and the density of building

sites may render existing vegetation requirements ineffective at maintaining the natural forest vegetation.

FOREST SITE SUMMARY

Island: Cape Fear
Site Name: Bald Head Island
Acres: 414

County: Brunswick
Number: 1
USGS Quad: Cape Fear

Location and Directions

Three islands make up the Smith Island complex of Cape Fear. Bald Head Island is the southernmost and largest of the three. It is accessible by private ferry from Southport. (See Fig. 16)

Site Description

The topography of the island is that of a dune ridge-swale system. The ridges are broad and slope gently into even broader swales. These swales can be either wet or dry depending on the local drainage patterns. The canopy is not very dense and is almost absent in some places. Where the canopy exists, Quercus virginiana is the most abundant species. Also in the sparse canopy are Quercus laurifolia and Sabal palmetto. Recruitment of Quercus virginiana is lacking.

One of the significant features of this forest is that there are many extremely old trees. One Quercus virginiana measured 178cm dbh. There are also old individuals of Sabal palmetto, Cornus florida, and Prunus caroliniana. The undergrowth throughout the forest is quite dense with many vine species such as Smilax bona-nox, Rhus radicans, Lonicera sempervirens, and Vitis aestivalis. The most common species of the understory shrub layer are Persea borbonia, Osmanthus americana, and Prunus caroliniana. Callicarpa americana is also common in this zone. Other than the various vines, the ground cover consists of Galium hispidulum, Mitchella repens, and large specimens (25cm high) of Asplenium platyneuron.

The sparse canopy can be attributed to wide spread tree blow downs following hurricanes and recent storms. The increased light conditions resulting from the sparse canopy have allowed a dense undergrowth layer to develop. With its southern and eastern exposure, the island gets hit hard and often by storms. This high frequency disturbance regime could keep the forest in a constant mosaic of successional growth.

Evidence of Disturbance

Disturbances within the forest of Bald Head Island have been both natural and anthropogenic in origin. Several roads cut through the forest with various loops and circles connecting roads in the west end. Federal Rd. is the main thoroughfare which bisects the island. Although the roads are only wide enough the accommodate golf cart traffic (8m right-of-way), they disturb the canopy to some degree and cut through dune ridges. Many old cedar stumps were observed throughout the forest indicating past logging. Although much of the east end of the island is undeveloped, there are survey lines that cut into the forest at frequent intervals.

Ecological Significance

The entire complex of islands is registered as a National Natural Landmark. This site is an example of a barrier island type more common to the islands of South Carolina and the Georgia Sea Isles. The subtropical influences create a climate in which plants and animals can live at the northern and southern limits of their ranges. The maritime forest on Bald Head Island is the largest maritime forest in the state which still has undeveloped, natural transition zones with both the sound-side salt marshes and the ocean side, open dune systems.

Current Forest Management

Bald Head Island has been the most intensely developed of the Cape Fear Islands (approximately 760 acres of maritime forest have been developed so far). This development includes single family residential housing, a condominium complex, and a golf course. Residential lots range in size from 10,000 to 15,000 square feet. The removal of vegetation is limited to the building site and for access to the property. A land use plan is currently being prepared as the community of Bald Head Island is soon to be incorporated. It will be the Town's policy that future development will cause minimal disturbance of the natural vegetation and features of the land.

According to the Bald Head Island Limited Company, future development will be concentrated in the eastern sections, and a 200-acre tract in the center of the island will be designated as a natural area. Such an island of forest in the midst of development would have diminished conservation value compared to the current maintenance of an undisturbed sound to ocean transition zone. Although an attempt is being made to maintain the natural character of the island, the lots platted within the forest are relatively dense, and according to future development plans, this density will likely increase.

The preservation of Bald Head and Middle Island's natural character would be greatly enhanced if the proposed lot sizes were increased (perhaps 80,000 square-feet) while maintaining the present policy of limited vegetation removal. The density issue should be addressed specifically in the pending land use plans and zoning ordinance.

Except for the development on the western end of the island, Bald Head at the present time is mostly undeveloped. Development, however, is sweeping eastward, starting in the dune areas, and then back into the forest. Lots are being cleared and roads are being built despite the relatively low number of lots actually being sold. This accelerated "phase II" development by the Bald Head Island Limited Company appears to be proceding without the widely publicized conservation measures inherent the originally proposed plans for the island.

Part IV. Management Recommendations and the Future of North Carolina's Maritime Forests

The maritime forest ecosystem is rapidly disappearing along the coast of North Carolina. As outlined in Part III, there are less than 25 large maritime forest sites (i.e., greater than 20 acres) remaining on the barrier islands (see Fig. 1). If we exclude northern Currituck Banks (5,000 acres of indiscrete sound side forest fringe) these sites total less than 7000 acres. Of these sites, 18 are partially or entirely in private ownership (see Appendix B). Given the current rate of barrier island development, most of this privately owned forest will be destroyed or significantly altered within the next decade.

We are at a critical point in determining the fate of maritime forests in North Carolina. Major changes in policy need to be made soon to prevent the loss of this unique ecosystem. We highly recommend that the following actions be taken towards maritime forest protection and preservation:

1. Development of maritime forests should be slowed down; uniform standards should be imposed on a state-wide basis to insure adequate protection. Area of Environmental Concern status, such as has been given to salt marshes and other important natural systems, should also be applied to the maritime forest ecosystem as a whole (as delineated in this report).

2) Current and future regulations need to be more rigorous with regard to the conservation of maritime forests. Regulations, whether they be local development standards, AEC use standards or Corps 404 wetland regulations, should be strictly enforced.

3) Attempts should be made at the state and federal level to purchase priority forest areas (See Appendix B). Those sites with the highest habitat diversity and largest size should be the initial focus of this drive.

4) Future research in maritime forests needs to be encouraged; public awareness and education programs are needed to convey the importance of maritime forests as an essential barrier island ecosystem and as a unique part of our coastal heritage.

APPENDIX A

Remaining Maritime Forest Tracts in North Carolina

Currituck Island

1) Northern Currituck Banks: Sound side strip including the Audubon Preserve (Pine Island) and the Currituck Shooting Club lands from the end of NC 12 to Corolla. 5000 acres

2) Kitty Hawk Woods: US 158 Bypass north of Kill Devil Hills. The area is between US 158 and Main Road, which runs through the center of the tract. 540 acres

3) Nags Head Woods: NC 12 West of Nags Head, north of Jockey's Ridge. Nature Conservancy land is accessible by Ocean Acres Drive in Kill Devil Hills. 755 acres

Colington Island

1) Schoolhouse Rd.: The forest area is located along Schoolhouse Rd., which is the first left after the second bridge on Colington Island. The sand road runs parallel to Colington Cut. 120 Acres

Roanoke Island

1) Forth Raleigh City-NPS: The site is located in and around the Fort Raleigh National Historic Site. One tract (100 acres) is located along US 64-264, three miles north of Manteo. The forest is at the end of a service road leading from the park headquarters, and extends beyond the Park Service boundaries up to SR 1161. A second tract (5 acres) is located on US 64-264, three miles west of Manteo. This tract is in the vicinity of the park nature trail and restored fort. 105 Acres (Total)

2) Weir Point: At the western tip of Roanoke Island, on the south side of US 64-264 approx. four miles west of Manteo. The site is immediately behind a rest area facility just before the bridge crossing Croatan Sound. 86 Acres

Hatteras Island

1) Buxton Woods: Sound side of NC 12 from Frisco to Buxton. 3000 acres

Shackleford Banks

1) Shackleford: South of Beaufort across Back Sound. Access by boat. 90 acres

Bogue Banks

1) Hoop Pole Creek: Atlantic Beach. From the western corporate boundary, 0.6mi. east on the northern side of NC 58. Access via a sand road at the historical marker marking the landing site of Northern troops during the seige of Ft. Macon. 12 Acres

2) Atlantic Station: Atlantic Beach. West side of Atlantic Station parking lot. Extends west along NC 58 to Hoop Pole Creek. Located on sound side of the island. 45 Acres

3) Ocean Ridge: Atlantic Beach. Across from the Atlantic Station shopping mall on the south side of NC 58. 15 Acres

4) Theodore Roosevelt Natural Area: Pine Knoll Shores. Extends from Pine Knoll Blvd. west on the north side of NC 58 for approx. 1.0mi. 290 Acres

5) Indian Beach: Indian Beach. About 0.5mi. within Indian Beach eastern limit on the north side of NC 58. Western boundary is a large vacant lot. 33 Acres

6) Salter Path: Salter Path. Immediately west of Salter Path Family Campground on the north side of NC 58 (40 Acres). There is also a smaller tract located directly across NC 58 (12 Acres) 52 Acres (Total)

7) Piney Point: Emerald Isle. Along immediate western boundary of Piney Point subdivision on the north side of NC 58. Heading west on 58, access is easiest by making a right on Lee Ave. Western boundary is Live Oak St. 50 Acres

8) Emerald Isle Canal: Emerald Isle. Just before Emerald Isle bridge. Accessible through the western boundary of the Emerald Isle Plantation development. 64 Acres

9) Emerald Isle Bridge: Located at the intersection of NC 58 and Coast Guard Rd. Sound side corner. Continues west to the Cape Emerald development (0.6mi.). 86 Acres

10) Emerald Isle Woods & Sound Strip: Coast Guard Rd. in Emerald Isle. The site is located between two developments, starting west of Cape Emerald subdivision west to a yet un-named development on the south side of Coast Guard Rd. 75 Acres

Huggin's Island

1) Huggin's Island: Bogue Inlet. West of the Emerald Isle bridge, East of Cape Carteret. Access is by boat from the NC 24 bridge leading to Swansboro (Cape Carteret side). 100 Acres

Bear Island

1) Hammocks Beach State Park: Swansboro. NC 24 south to Swansboro (there will be a sign). From June to September months there is a free ferry to Bear Island. The forest is on the north end of the island on the sound side. 70 Acres

Topsail Island

1) Pirates Cove: Surf City. The site is three miles south of the northern NC 210 bridge, on the sound side of NC 50. Access is by way of a sand road that cuts back into the forest. 54 Acres

Cape Fear

1) Bluff Island: Access from East Beach. 70 Acres.

2) Middle Island: Access via Federal Rd. from Bald Head. 100 Acres.

3) Bald Head Island: Access via private ferry from Southport. 414 Acres.

APPENDIX B

North Carolina Maritime Forest Sites: Protection Priorities

	Ownership *
I. Top Priority Sites	
A. >100 Hectares	
1. Kitty Hawk Woods	P
2. Buxton Woods	F,S,P
3. Bald Head Island	P
4. Nags Head Woods	L,P
5 Theodore Roosevelt Natural Area	S
B. >25 Hectares	
1. Bridge Site, Emerald Isle	P
2. Emerald Isle Woods and Sound Strip	P
3. Huggin's Island	P
4. Canal Site, Emerald Isle	P
5. Salter Path, Bogue Banks	P
6. Shackleford Banks	F
7. Bluff Island, Cape Fear	S
C. >10 Hectares	
1. Pirates Cove, Topsail Island	P
2. Piney Point, Emerald Isle	P
3. Indian Beach, Bogue Banks	P
4. Schoolhouse Rd. Site, Colington Island	P
II. High Priority Sites	
A. >100 Hectares	
1. Northern Currituck Banks	P
B. >25 Hectares	
1. Fort Raleigh City, Roanoke Island	F
2. Middle Island, Cape Fear	P
3. Bear Island	S
C. >10 Hectares	
1. Weir Point, Roanoke Island	P
D. >5 Hectares	
1. Ocean Ridge, Bogue Banks	P
2. Atlantic Station, Bogue Banks	L
3. Hoop Hole Creek, Bogue Banks	P

* F=Federal; S=State; L=Local; P=Private
1 Hectare= 2.47 Acres

APPENDIX C

Principal Land Owners of Maritime Forest Tracts in North Carolina

Currituck Island

Northern Currituck Banks:

National Audubon Society
Southeast Regional Office
PO Box 1268
Charleston, SC 29402
— owns 4158 acres in Currituck (Pine Island Sanctuary includes marsh)

Currituck Shooting Club
PO Box 66
Poplar Branch, NC 27965
— owns 2100 acres in Currituck County (1651 acres are marsh)

Kitty Hawk Woods:

Kitty Hawk Woods Partnership
Quentin Bell Company
PO Box 749
Kitty Hawk, NC 27949
— owns approx. 2,000 acres Subdivided into 3 and 10-acre lots

Partnership Individuals

Terry Dixon
31 Circle Dr.
Kitty Hawk, NC 27949

Lannie Belangia
Point Harbor, NC

Jerry Wright

J. Fred Bender

Nags Head Woods:

North Carolina Nature Conservancy
PO Box 805
Chapel Hill, NC 27514
— owns 360 acres

Town of Nags Head
PO Box 99
Nags Head, NC 27959
— owns 350 acres

Nags Head Woods Partnership
Brock Daniels
— owns 400 acres

Colington Island

Schoolhouse Rd.:

David Stick
Kitty Hawk, NC 27949
— owns 48 acres

Ralph Reed, Jr.
PO Box 1400
Manteo, NC 27954
— owns 32 acres

First Pioneer Investment Co.
PO Box 2088
Rocky Mount, NC 27802 — owns 25 acres

Michael Stick
111 N. Dearborn
Apt. 1606
Chicago, IL 60610 — owns 14 acres

Barbara Bramble
c/o Toby Bramble
PO Box 962
Boulder, CO 80306 — owns 15 acres

Roanoke Island

NPS Service Rd.:
National Park Service
Fort Raleigh National
Historic Site
Route 1, Box 675
Manteo, NC 27954 — owns 56 acres

Pearse Ins. & Realty Co., Inc.
Box 205
Manteo, NC 27954 — owns 70 acres

Rial Corp.
c/o Wm. C. Stillwagon
319 Maple Ave.
Greensburg, PA 15601 — owns 21 acres

NPS Nature Trail:

National Park Service
Fort Raleigh National
Historic Site
Route 1, Box 675
Manteo, NC 27954 — owns entire site (5 acres)

Weir Point:

Capt. W.W. Harvey Jr.
330 Washington St.
Apt. 2
Portsmouth, VA 23704 — owns 30 acres

Hatteras Island

Buxton Woods:

National Park Service — owns 920 acres

Cape Hatteras National Seashore
Route 1, Box 675
Manteo, NC 27954

State of North Carolina — owns 330 acres
NC Coastal Reserve

Cape Hatteras Water Association — owns 216 acres

Phipps Foundation

Blades heirs

Midgett heirs

Shackleford Banks

Shackleford:

National Park Service
Cape Lookout National Seashore — owns entire site
Beaufort, NC 28516

Bogue Banks

Hoop Pole Creek:

Zachary Taylor Trustee
PO Box 1088 — owns 7 acres
New Bern, NC 28560

Coastal Lodging Corporation
6120 St. Giles St. — owns 5 acres
Raleigh, NC 27612

Atlantic Station:

Town of Atlantic Beach
PO Box 10 — owns 59 acres (includes marsh)
Atlantic Beach, NC 28512

Ocean Ridge:

Bogue Banks Baptist Church — owns 5 acres

(subdivided) — 10 acres

Theodore Roosevelt Natural Area:

State of North Carolina — owns entire site
North Carolina Department of
Natural Resources and Community
Development

Indian Beach:

White, Richard M. (Trustee) 7100 N Kendall Dr. Miami, FL 33156	owns entire site
Bogue Development Partnership 6000 High Bluff Ct. Raleigh, NC 27612	owns area around the tennis courts

Salter Path:

Baptist Childrens Home Indian Beach, NC	owns 4.7 acres, approx. 2 acres are forested
Taylor, Margaret L. Phillips 600 Yarmouth Rd. Raleigh, NC 27607	owns 19.1 acres
White, Richard M. (Trustee) 7100 N Kendall Dr. Miami, FL 33156	owns 37.1 acres which includes scrub site across NC 58

Piney Point:

Surfside Realty Company Inc. 100 Manatee St. Swansboro, Nc 28584	owns 48 acres

Emerald Isle Canal:

SPS Associates C/O Spell Realty Emerald Isle, NC 28594	subdivided

Emerald Isle Bridge:

Spell, Lawrence S. 8810 Emerald Dr. Emerald Isle, NC 28594	owns 32 acres
Cape Fear Company BB&T Trust Company PO Box 1847 Wilson, NC 27893	owns 41 acres

Emerald Isle Woods:

Singleton, J. A. Jr. 9030 Emerald Dr. Emerald Isle, NC 28594	owns 17 acres

Huggins Island

Huggins Island:

Donald W. & Doris B. Lynch
Rt 1 Box 1752 — owns entire island
Kilmarnock, VA 22482

Bear Island

State of North Carolina — owns entire site
Hammocks Beach State Park
Route 2, Box 295
Swansboro, NC 28584 (919) 326-4881

Topsail Island

Pirates Cove:

A.H. Ward — owners/developers
Alva H. Ward III
David Ward
Ward Reality Company
Surf City, NC

Cape Fear

Bluff Island:

State of North Carolina — owns entire island
70 acres

Middle Island:

Charles Young
Young Realty Inc. — owns entire island
Charlotte, NC (100 acres)

Bald Head Island:

George Mitchell
Bald Head Island Limited Company — owner/developer
Bald Head Island, NC 28461 (414 acres)

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